

AIA Conference on Architecture

WoodWorks Learning Lounge

Presented by WoodWorks

June 8 and 9, 2023



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Using Wood to Achieve Embodied-Carbon Reductions in the Built Environment

Course Number LL902

Thursday, June 8, 2023, 12:00pm - 1:00pm

Learning Units 1.00 LU/RIBA



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Questions related to specific products and services may be addressed at the conclusion of this presentation.

Course Description

Green building practices have historically focused on operational energy efficiency – but as building operations become more efficient, efforts have expanded to include embodied carbon and our choice of building materials. With low manufacturing emissions and the added benefit of long-term biogenic carbon storage, many designers are turning to wood products to reduce the carbon impact of their building designs. This presentation will highlight the ways wood contributes to lower embodied carbon, explain biogenic carbon storage, and provide clarity on the carbon accounting methods outlined in international standard ISO 21930. Differences in LCA tools – and how they align with or deviate from the ISO standard – will also be discussed. Finally, this presentation will address specific items for consideration when evaluating different structural systems using comparative LCAs.

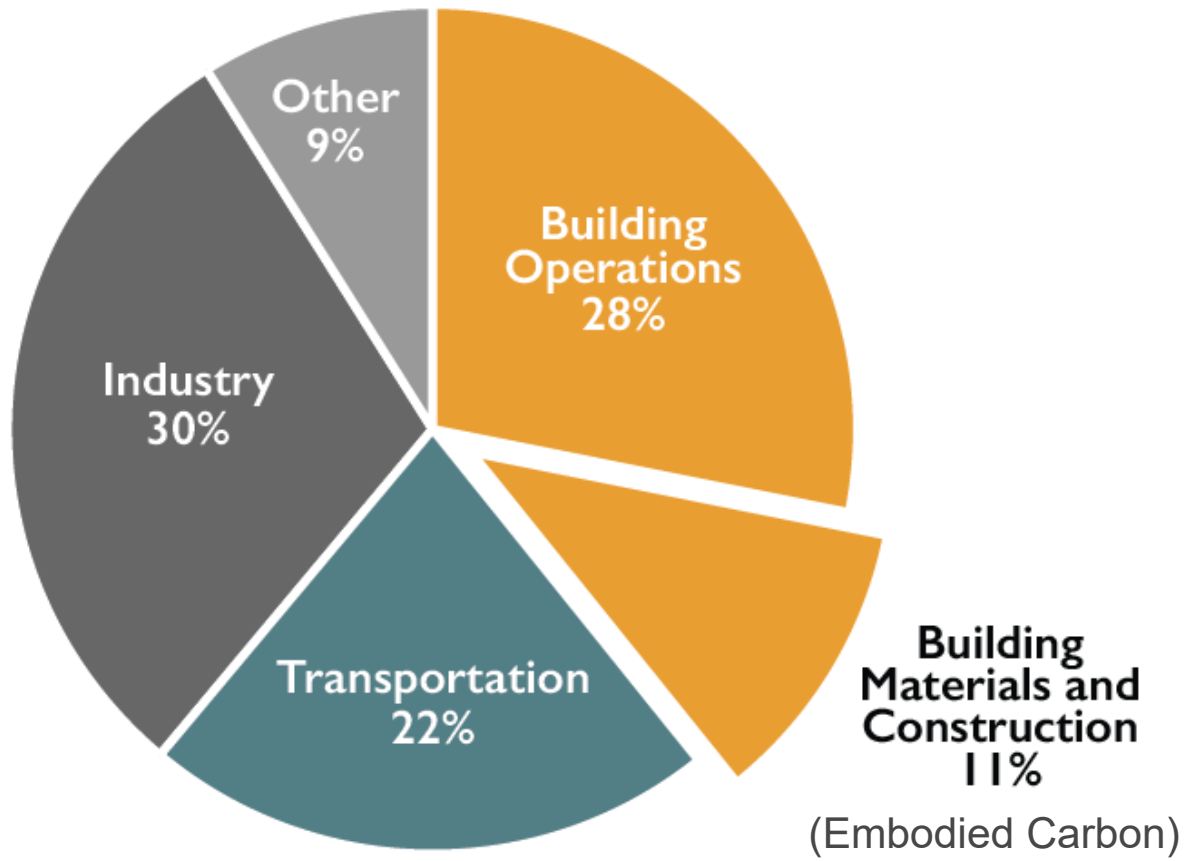
Learning Objectives

1. Review the low embodied carbon and carbon storage capabilities of wood products.
2. Understand how to calculate the amount of carbon stored in a wood product.
3. Learn how biogenic carbon is included in life cycle carbon accounting according to ISO standards.
4. Explain how whole building life cycle assessment is used to make comparisons between different materials and structural systems.

Carbon in Wood Buildings

New Buildings & Greenhouse Gases

Global CO₂ Emissions by Sector



Buildings generate nearly **40%** of annual global greenhouse gas emissions (*building operations + embodied energy*)

Embodied carbon: **11%**
Concrete, iron, steel **~9%**

Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

Image: Architecture 2030

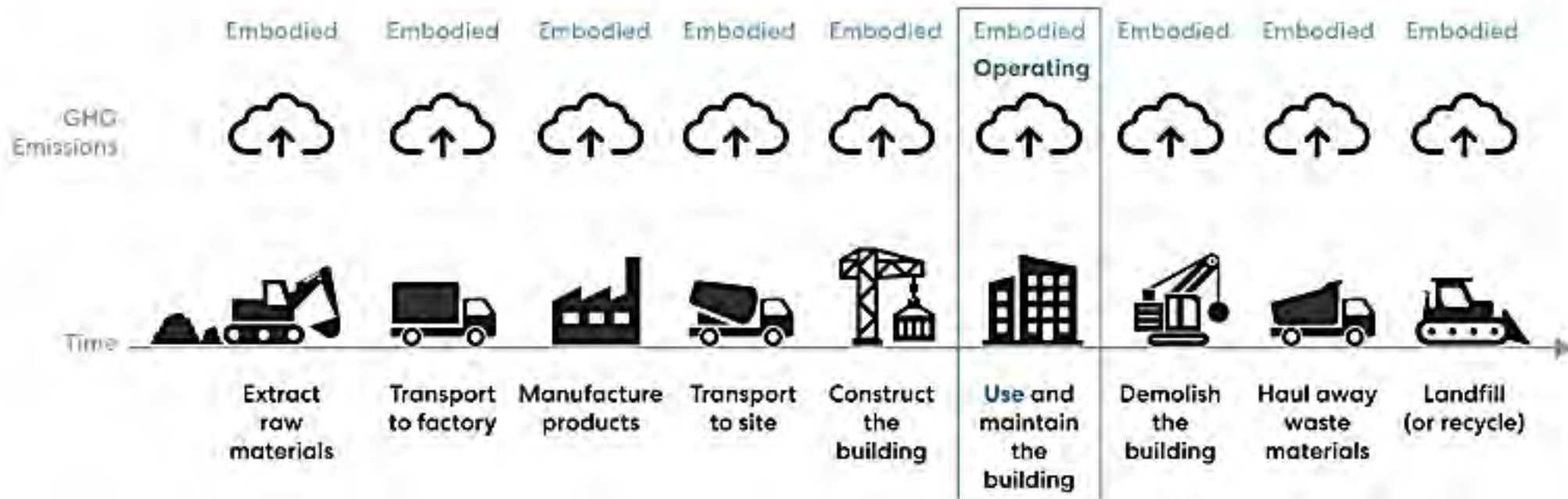
Carbon Terms

- **Embodied Carbon:** Carbon emissions associated with the entire life cycle of the building including harvesting, mining, manufacturing, transporting, installing, maintaining, decommissioning, and disposing/reuse of a material or product
- **Operational Carbon:** Carbon emissions associated with operating a building including power, heat, and cooling



Embodied Carbon

- Primarily related to **manufacturing of materials**
- More significant than many people realize, has been **historically overlooked**
- Big upfront GHG “cost” - which makes it a **good near-term target** for climate change mitigation



Carbon Benefits of Wood

- **Less energy intensive** to manufacture than steel or concrete
- **Less fossil fuel consumed** during manufacture
- Reduce process emissions
- Carbon **storage in forests** and **promote forest health**
- Extended carbon **storage in products**

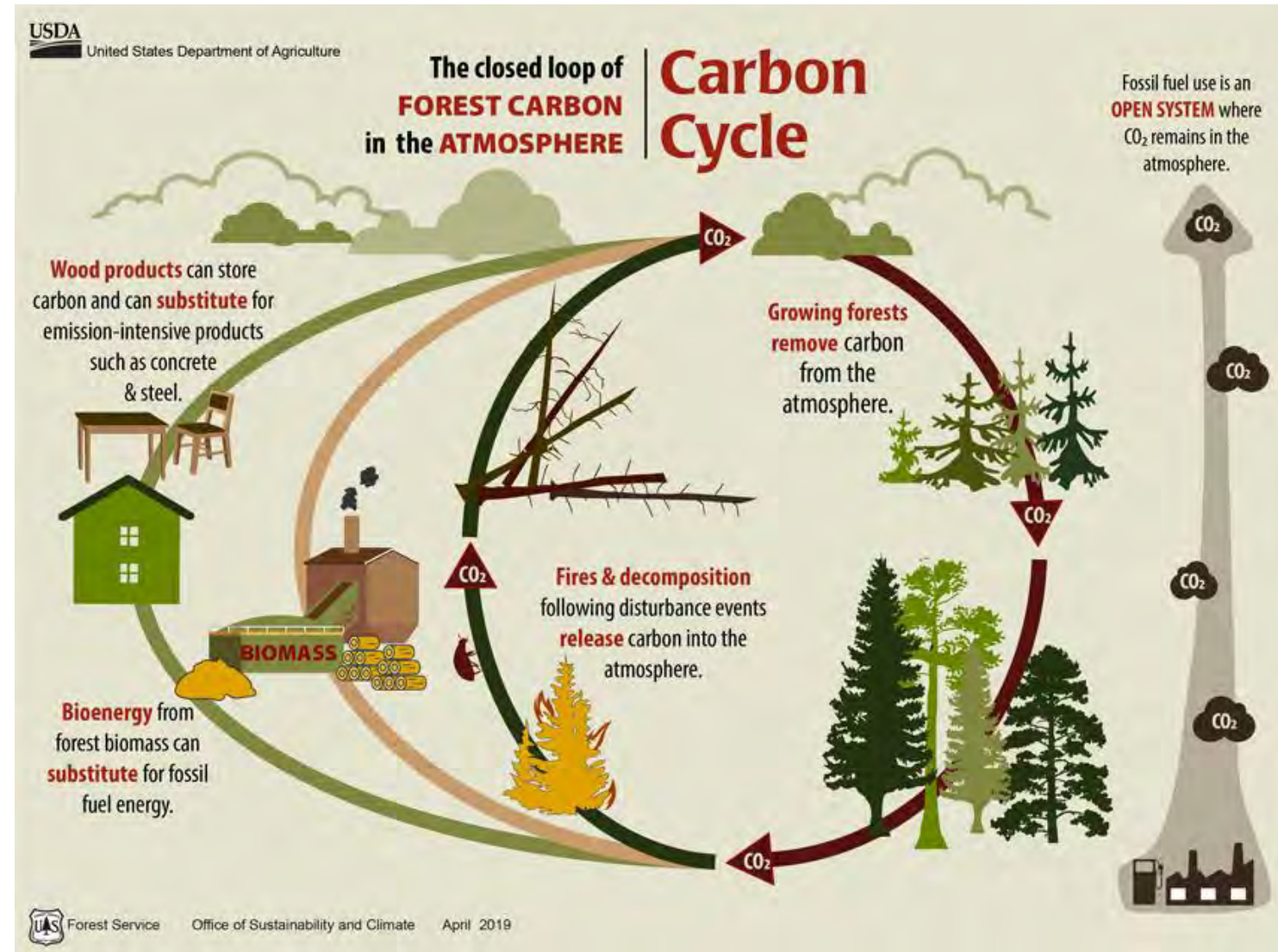


Image: USDA US Forest Service

Carbon Storage

Wood \approx 50% Carbon (dry weight)



Image: Kaiser + Path



Image: Lever Architecture

Carbon vs CO₂



1 ton Carbon \neq 1 ton CO₂

1 ton Carbon = (44/12=) 3.67 tons CO₂

Quantifying the Benefits

Life Cycle Assessment (LCA)

“Evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle”

- » Systematic, scientific **quantification**


Used for:

- » Single products or processes: e.g., a wood product
- » Complex, integrated systems: e.g., an entire building (**WBLCA**)

Life Cycle Assessment (LCA)

“Evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle”

Environmental Impacts:

- » Global Warming Potential (GWP) 
- » Ozone depletion
- » Smog formation
- » Acidification
- » Eutrophication
- » Depletion of nonrenewable resources
- » Etc.

Life Cycle Assessment (LCA)

“Evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle”

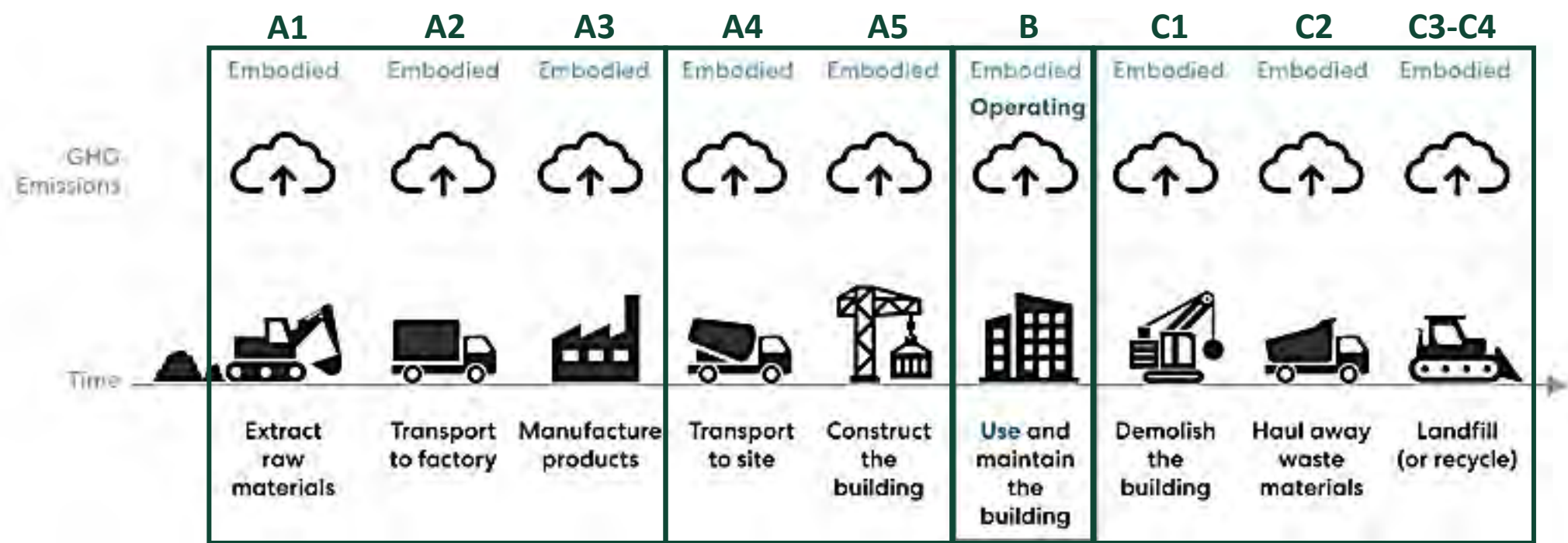
Environmental Impacts:

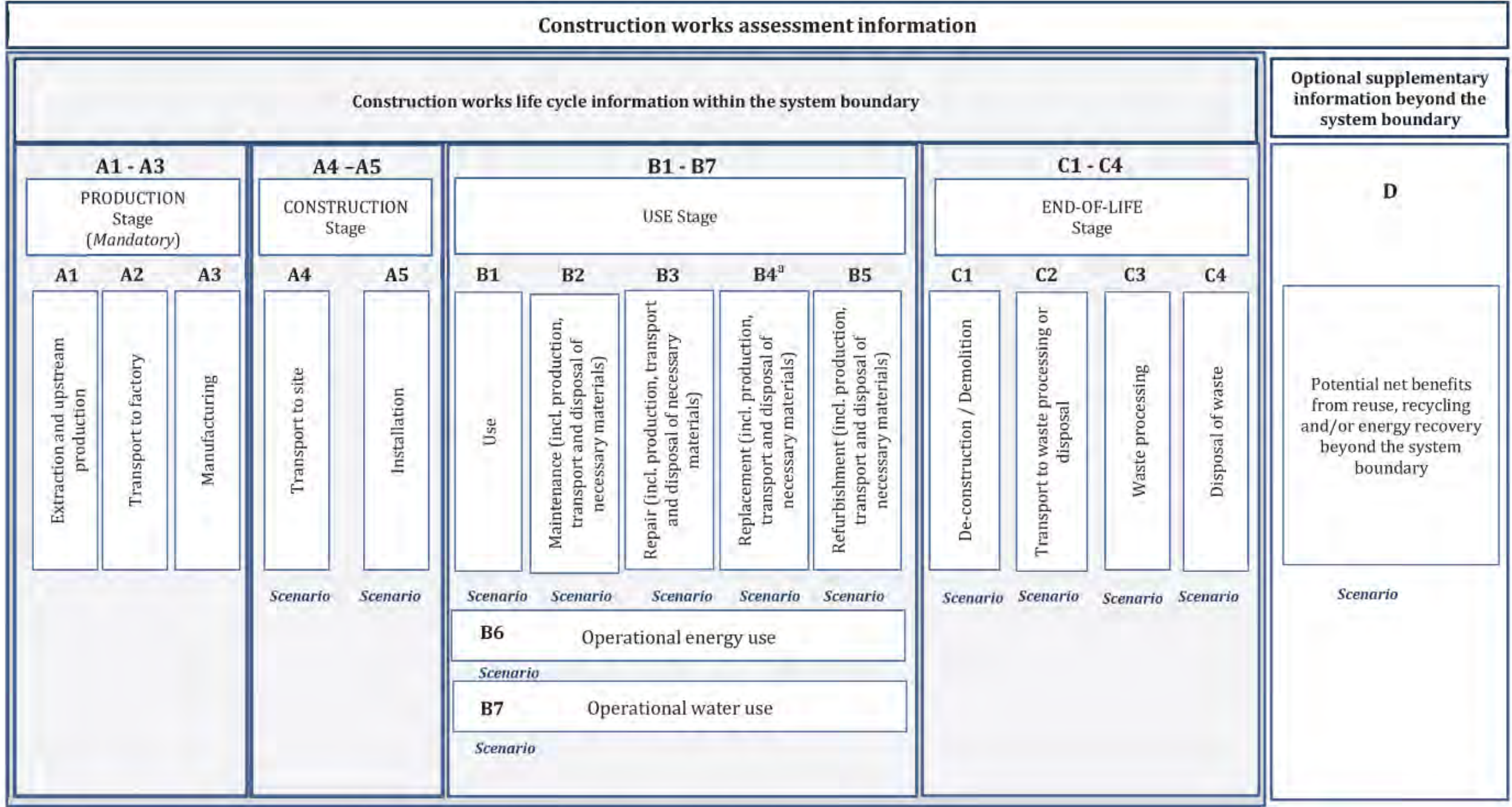
- » Global Warming Potential (GWP)
- » Ozone depletion
- » Smog formation
- » Acidification
- » Eutrophication
- » Depletion of nonrenewable resources
- » Etc.

Life Cycle Stages:

- » Harvesting or mining
- » Manufacture
- » Transportation and installation
- » Maintenance, repair and replacement
- » Decommissioning and disposal/reuse

Life Cycle





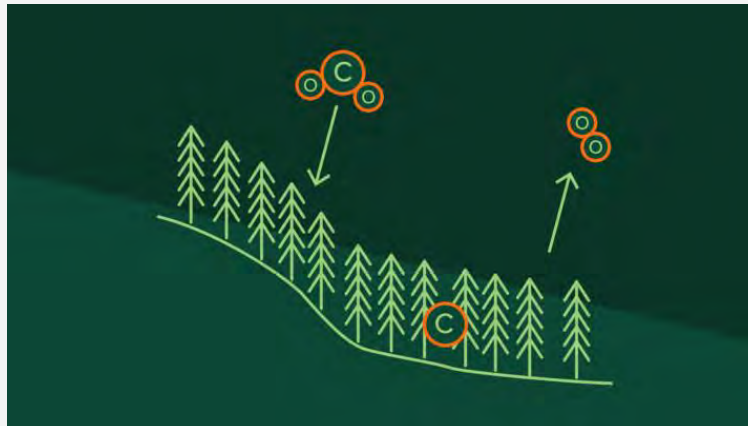
^a Replacement information module (B4) not applicable at the product level.

What makes wood different?

Biogenic Carbon

“Carbon derived from... material of biological origin
excluding material embedded in geological formations or
transformed to fossilized material and excluding peat.”

Photosynthesis:



Biogenic Carbon

“Bio-based materials originating from renewable resources (such as wood...) contain biogenic carbon.”

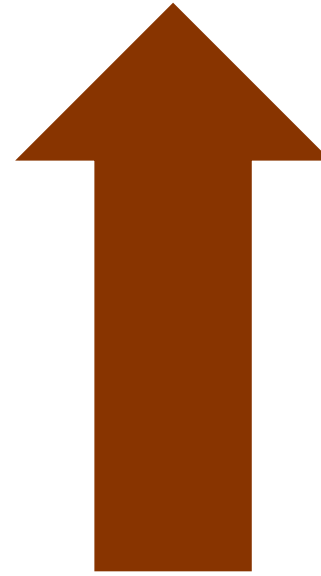
- » Biogenic carbon removals and emissions **shall be reported** as CO₂ in the LCI
- » When entering the product system (**removal**), characterized with a factor of **-1**
- » When converted to emissions (**emission**), characterized with a factor of **+1**
- » When leaving the product system (**export**), characterized with a factor of **+1**

Biogenic Carbon Accounting



-1 in

Removal of
carbon from the
atmosphere



+1 out

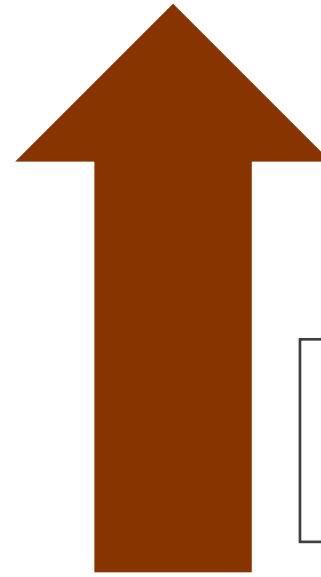
Emission or export
of carbon from
product system

Biogenic Carbon Accounting



-1 in

Removal of
carbon from the
atmosphere



+1 out

Note that “exports” are
not direct emissions to
the atmosphere.

Emission or export
of carbon from
product system

Biogenic Carbon

“For wood, biogenic carbon may be characterized with a -1...
when entering the product system **only when the wood
originates from sustainably managed forests.**”

So...

What is a sustainably managed forest?

Sustainably Managed Forests

“... zero emissions associated with land use change”

Option 1:

Includes wood products *responsibly sourced and certified* to:

- » **Standards** globally endorsed by PEFC and FSC
- » FSC, SFI, CSA, ATFS, etc.

Option 2: (NOTE 2)

- » “The concept of sustainably managed forests is linked but not limited to respective certification schemes”
- » Evidence such as national reporting under UNFCCC to identify forests with stable or increasing forest carbon stocks

Sustainably Managed Forests

“... zero emissions associated with land use change”

Option 1:

Includes wood products *responsibly sourced and certified* to:

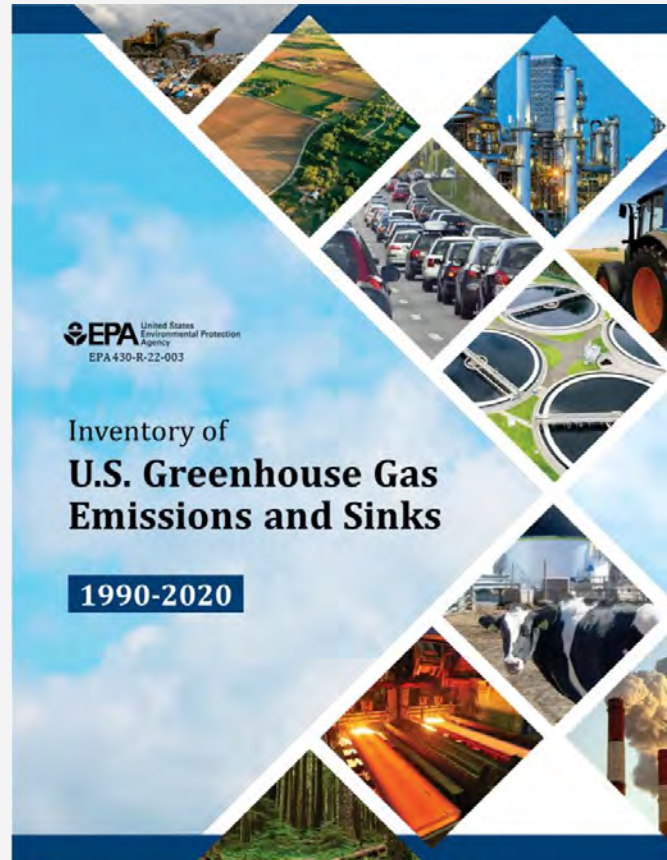
- » **Standards** globally endorsed by PEFC and FSC
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Option 2: (NOTE 2)

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UNFCCC National Reporting

“... stable or increasing forest carbon stocks”



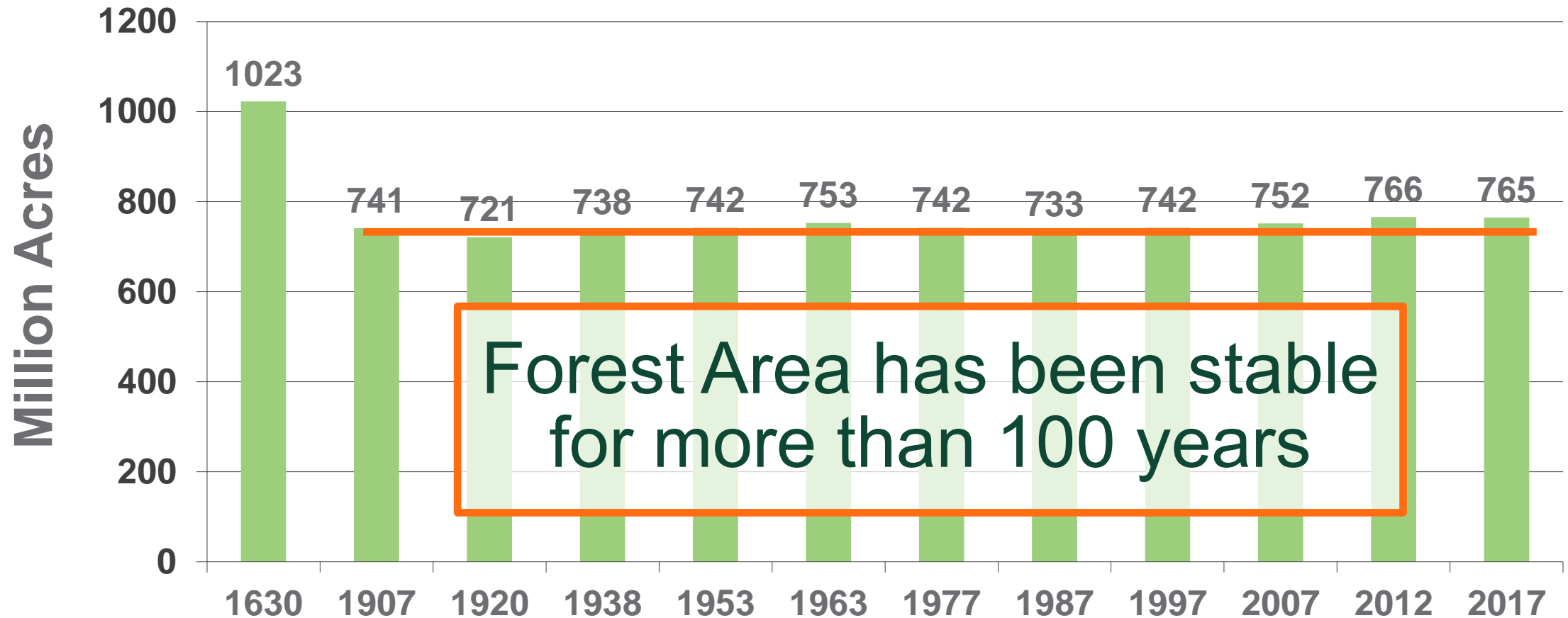
See Table 6-10



See Table 6-1

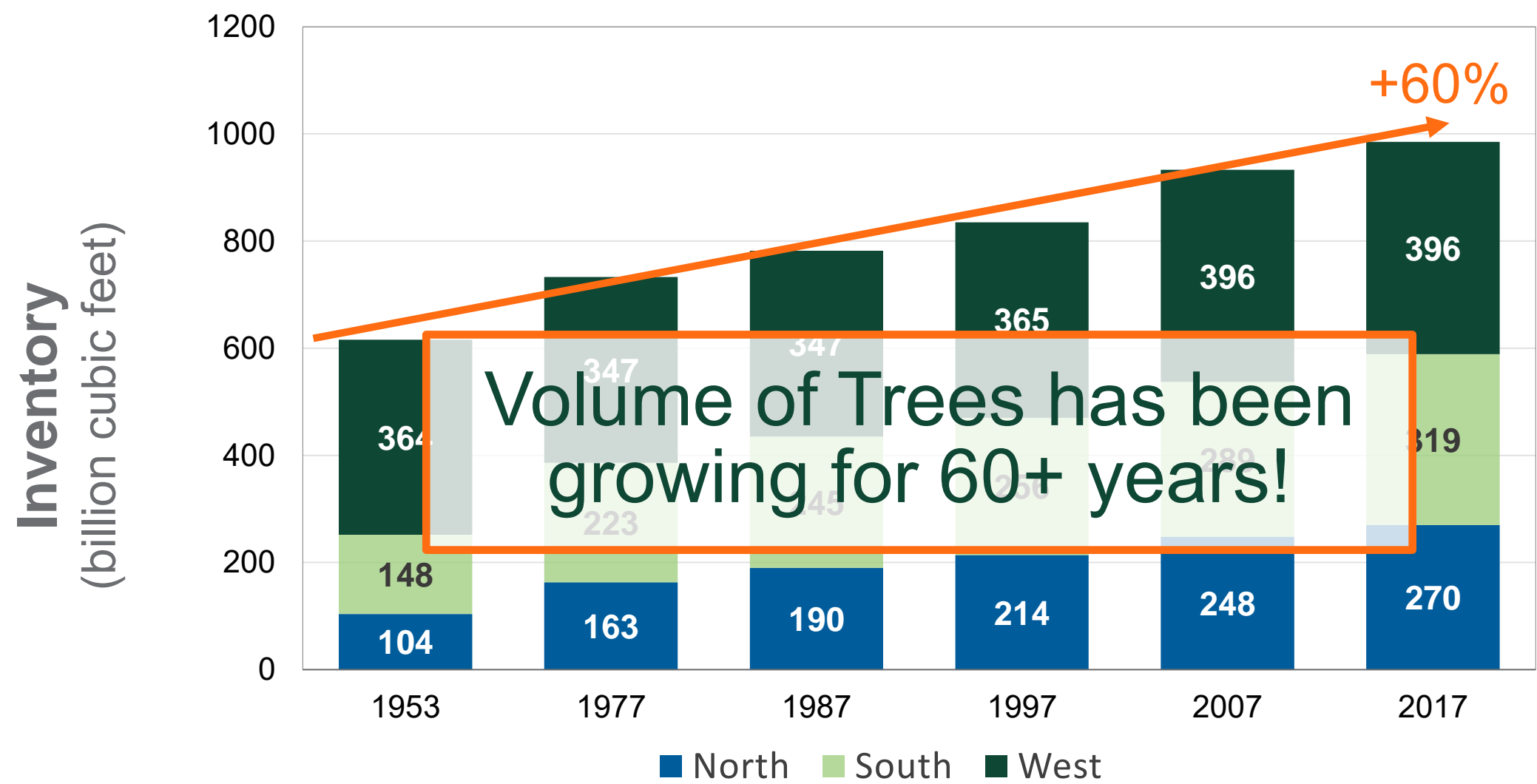
U.S. Forest Land:

Forest Area in the United States 1630 – 2017



Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland

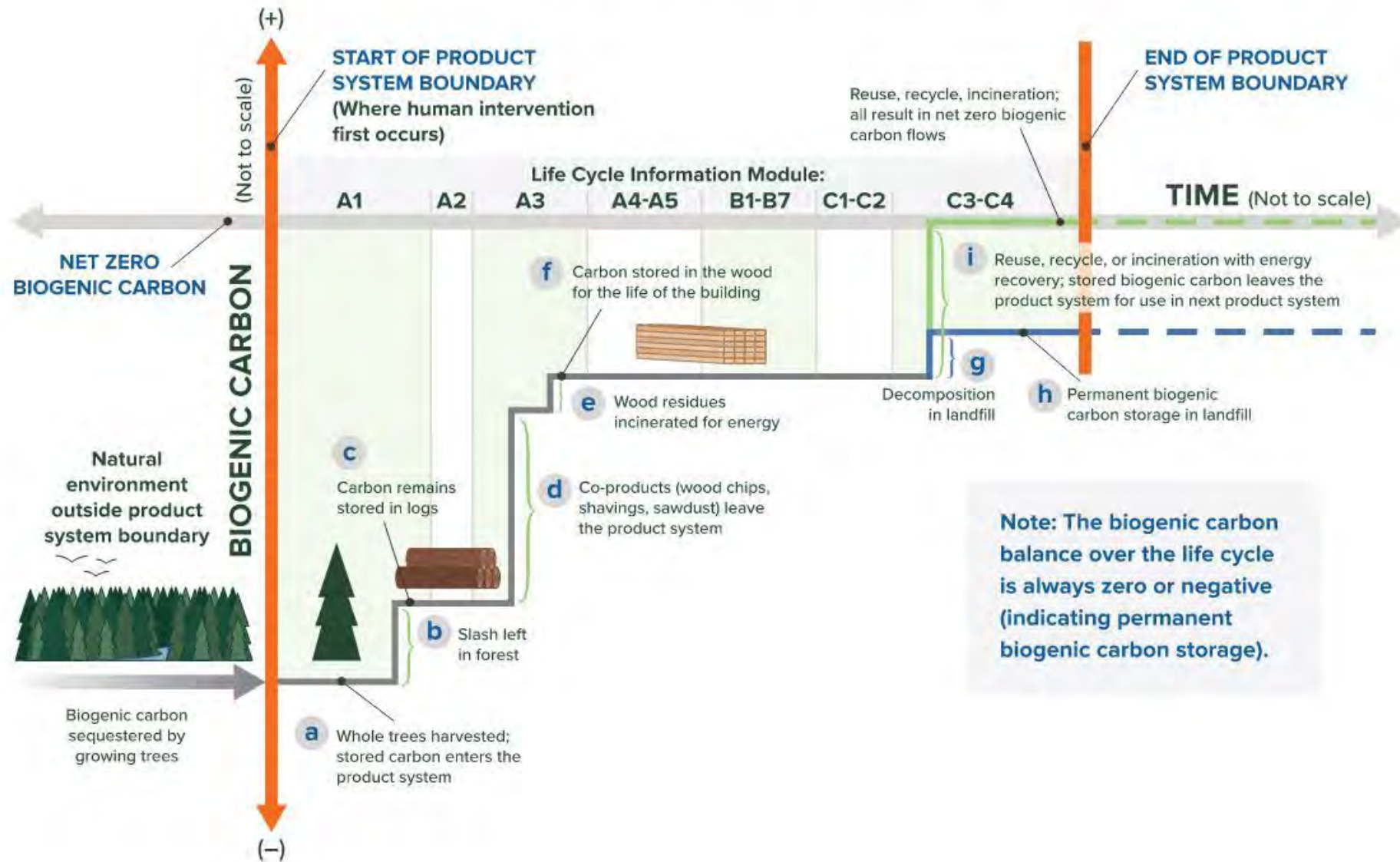


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

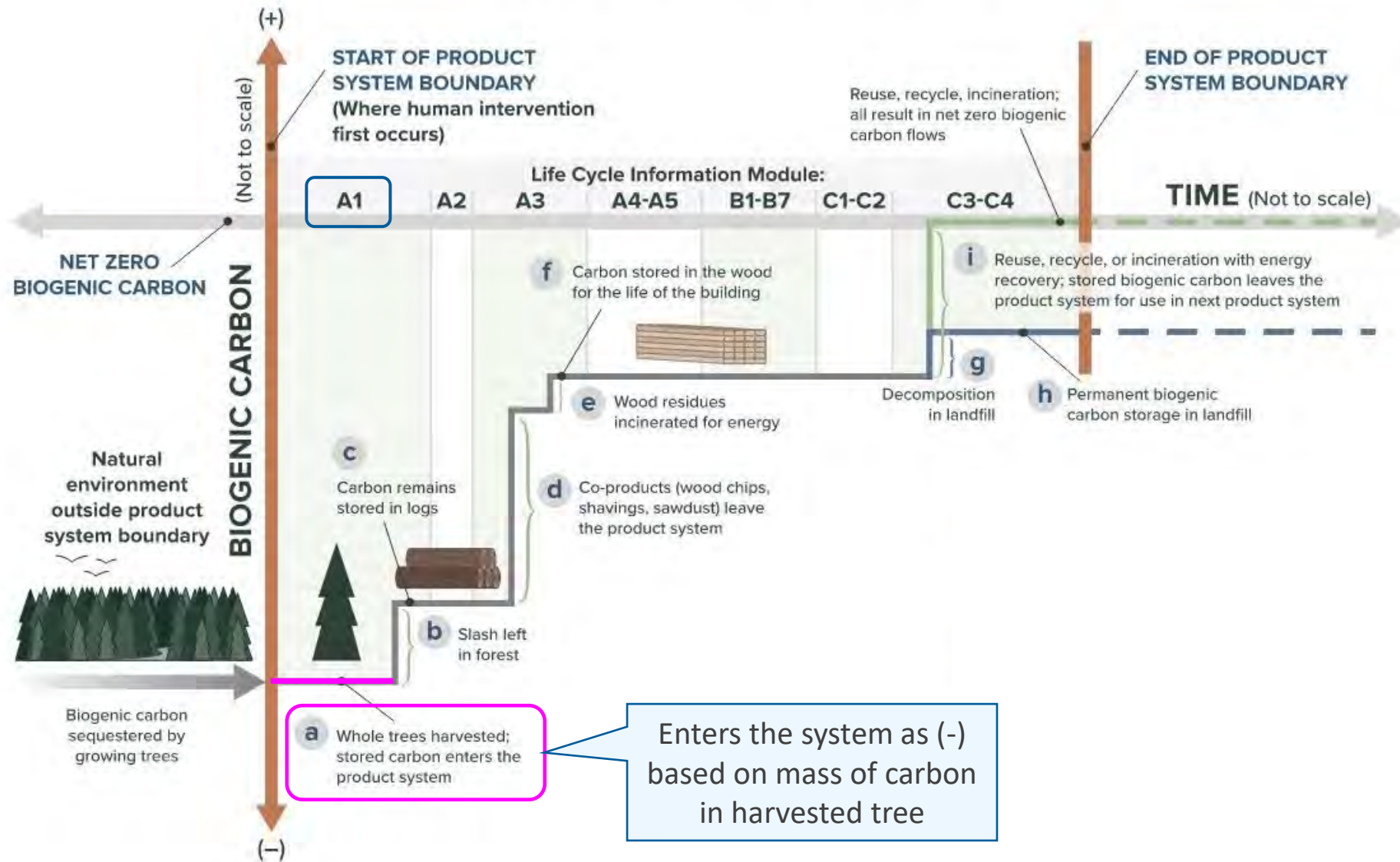
**Should I include biogenic
carbon?**

Yes! But how?

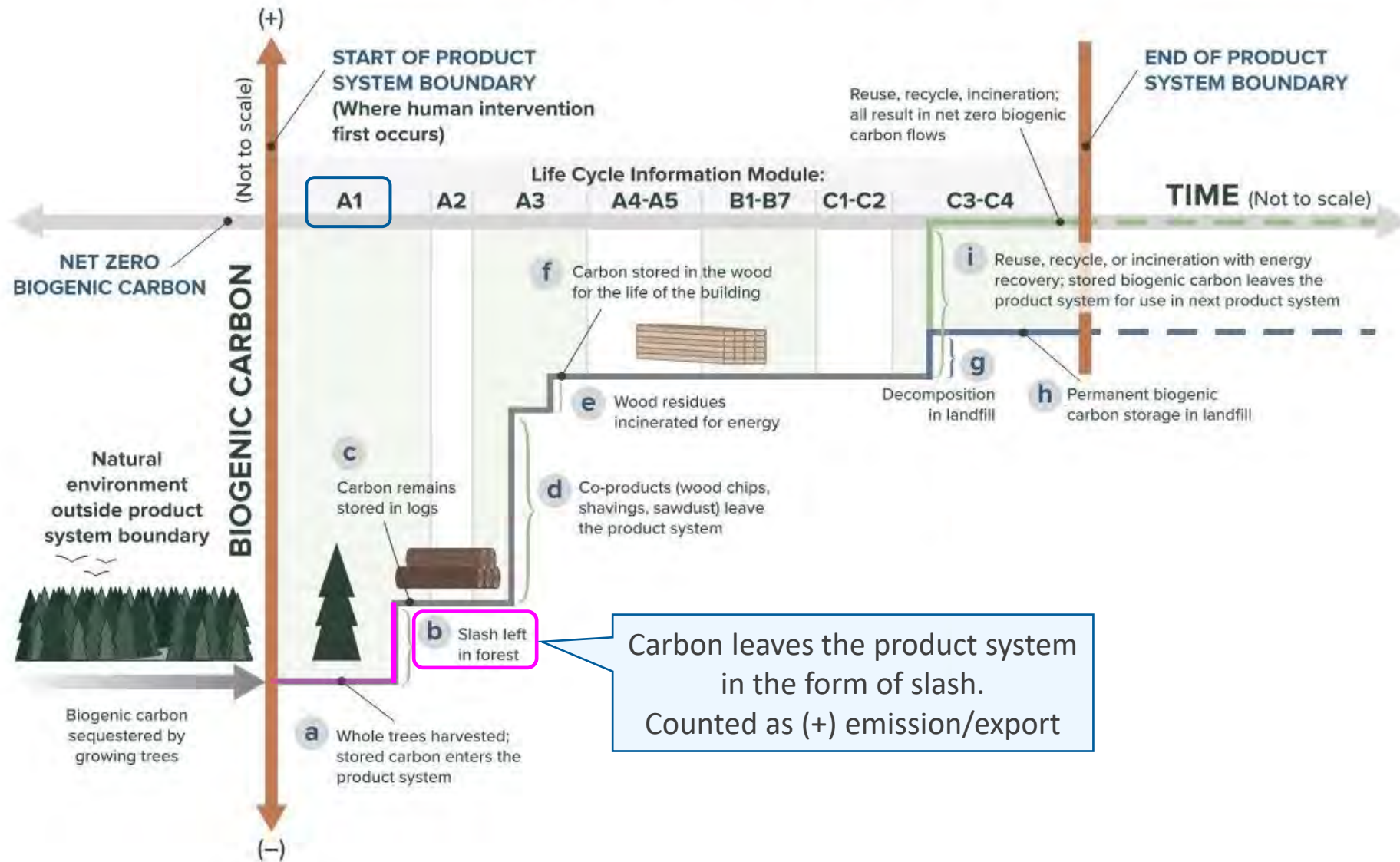
BIOGENIC CARBON FLOWS



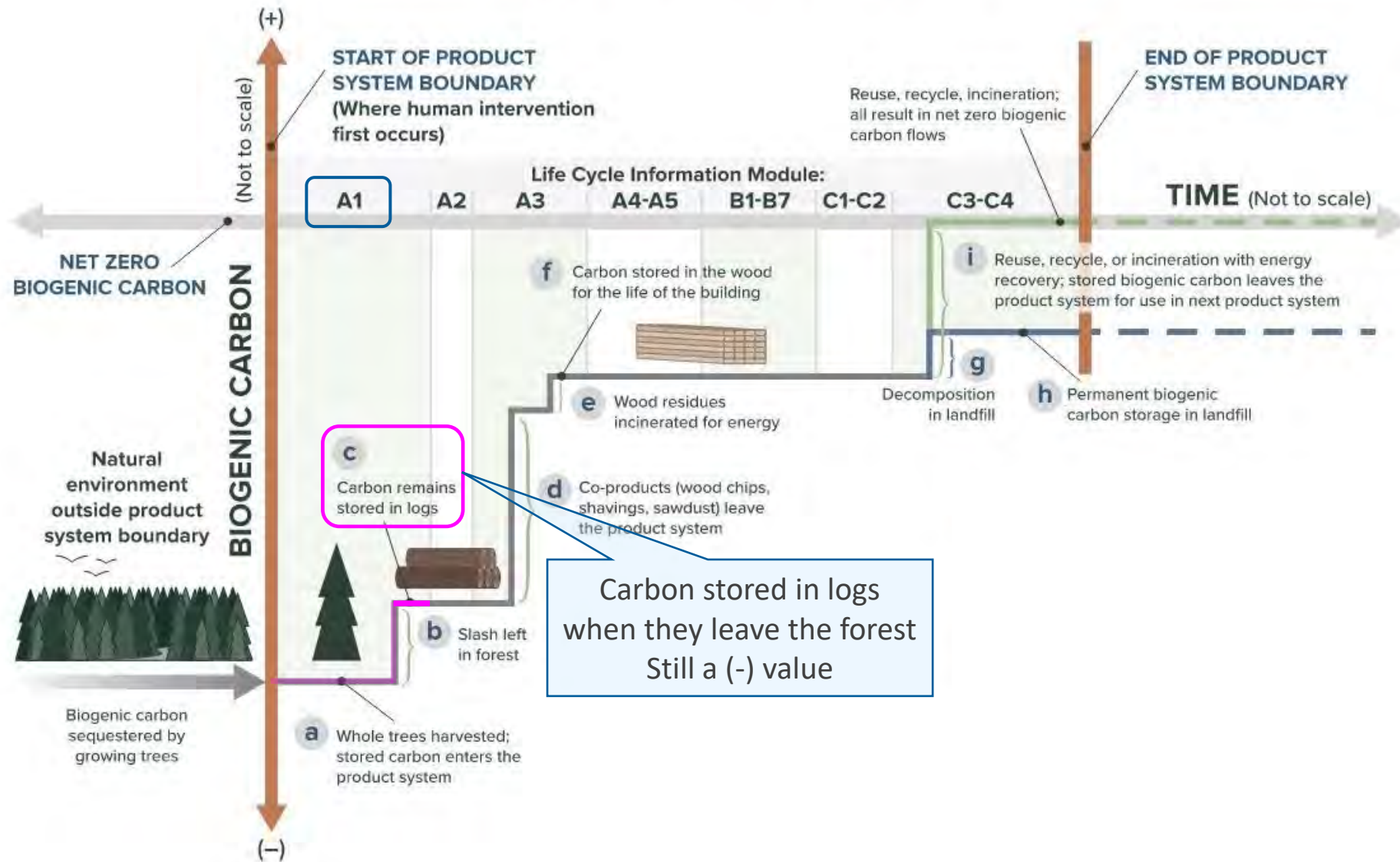
BIOGENIC CARBON FLOWS



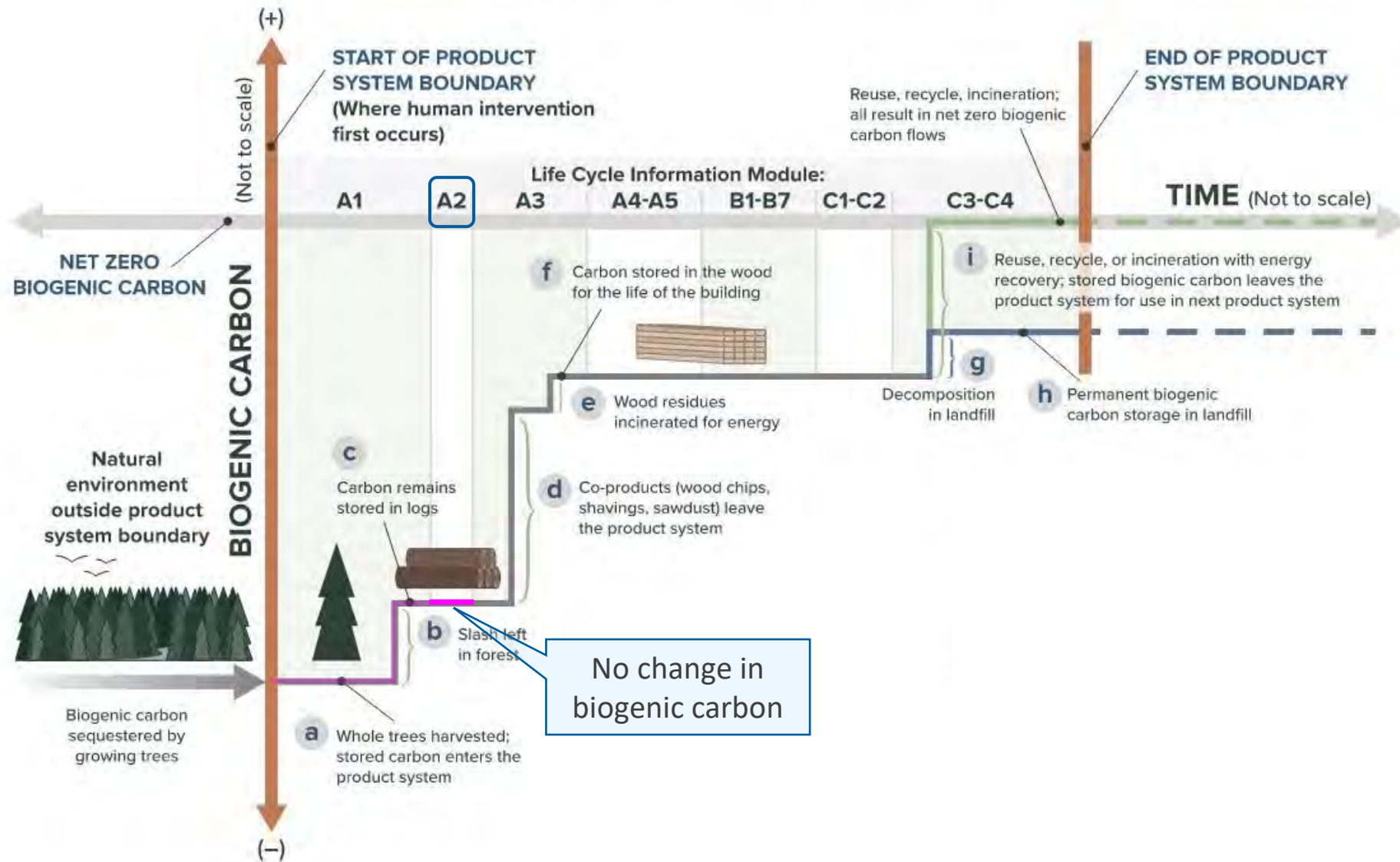
BIOGENIC CARBON FLOWS



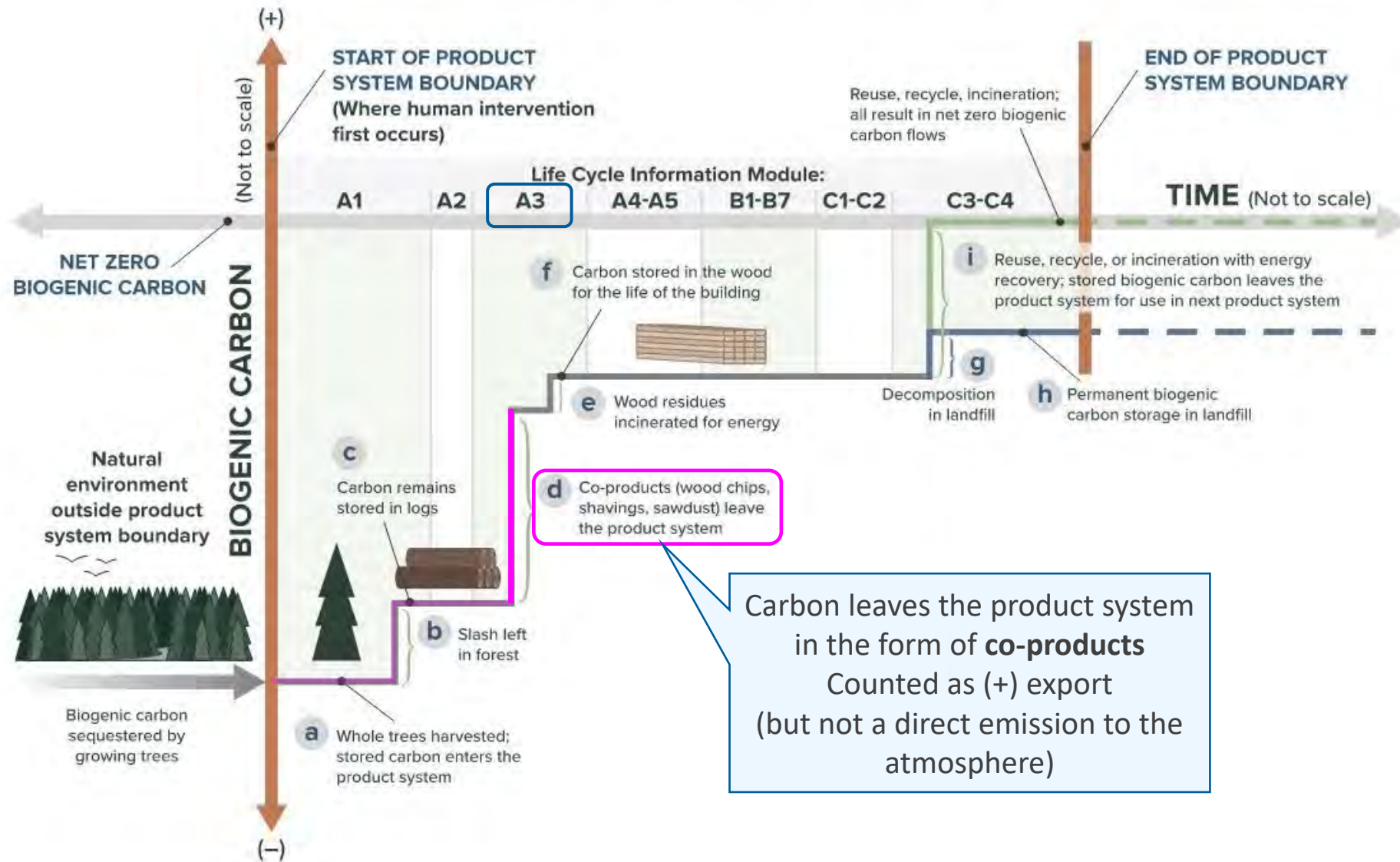
BIOGENIC CARBON FLOWS



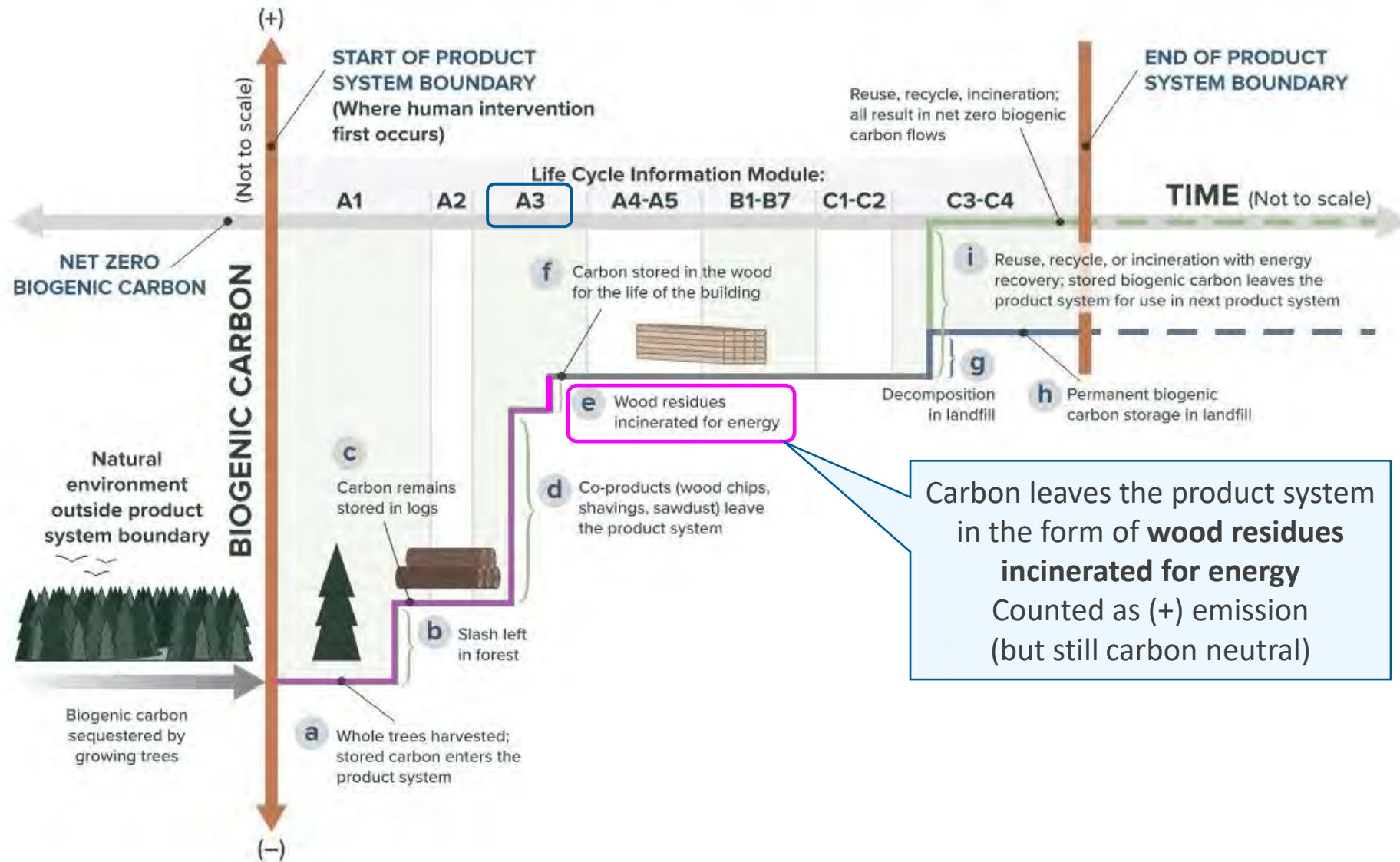
BIOGENIC CARBON FLOWS



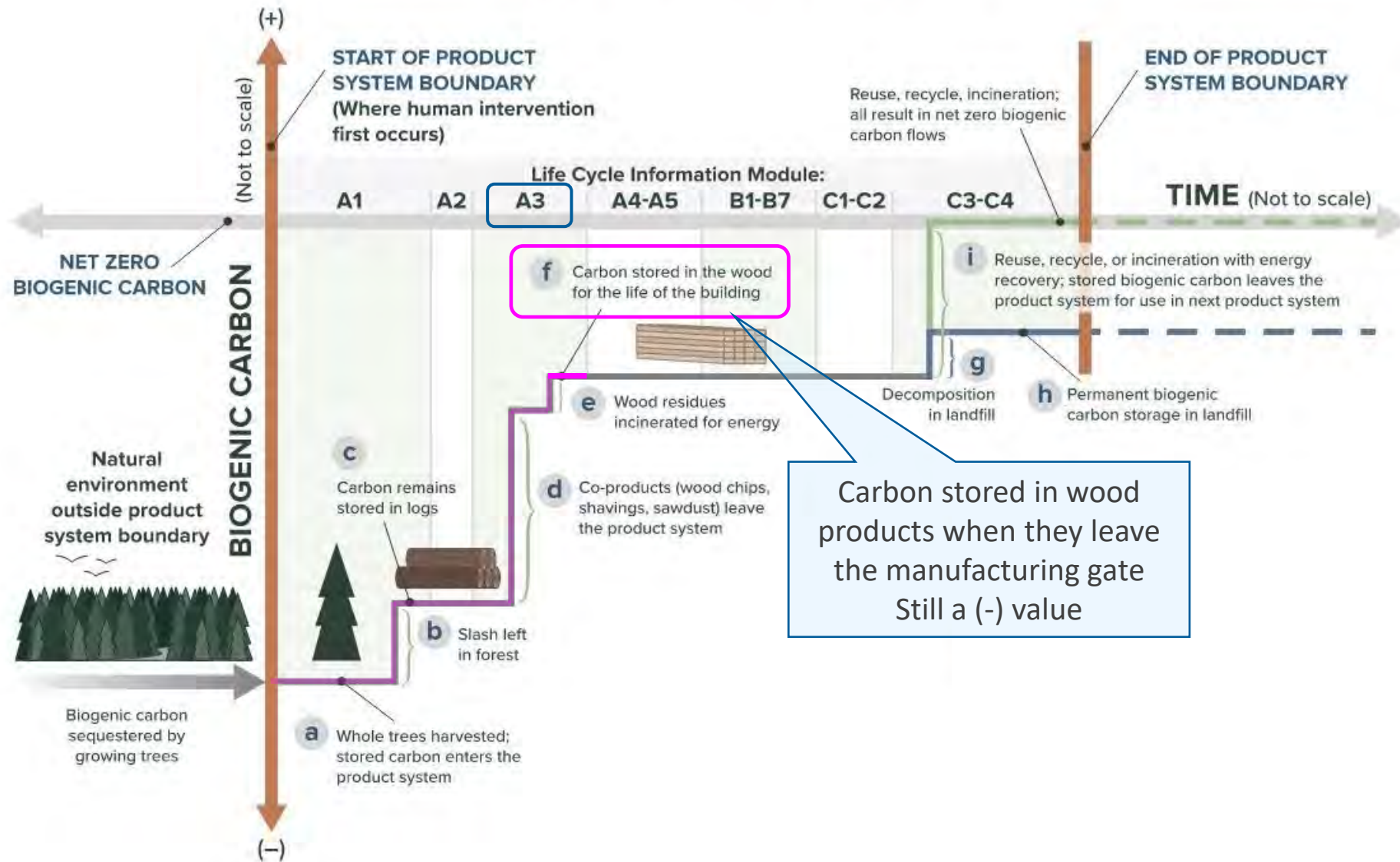
BIOGENIC CARBON FLOWS



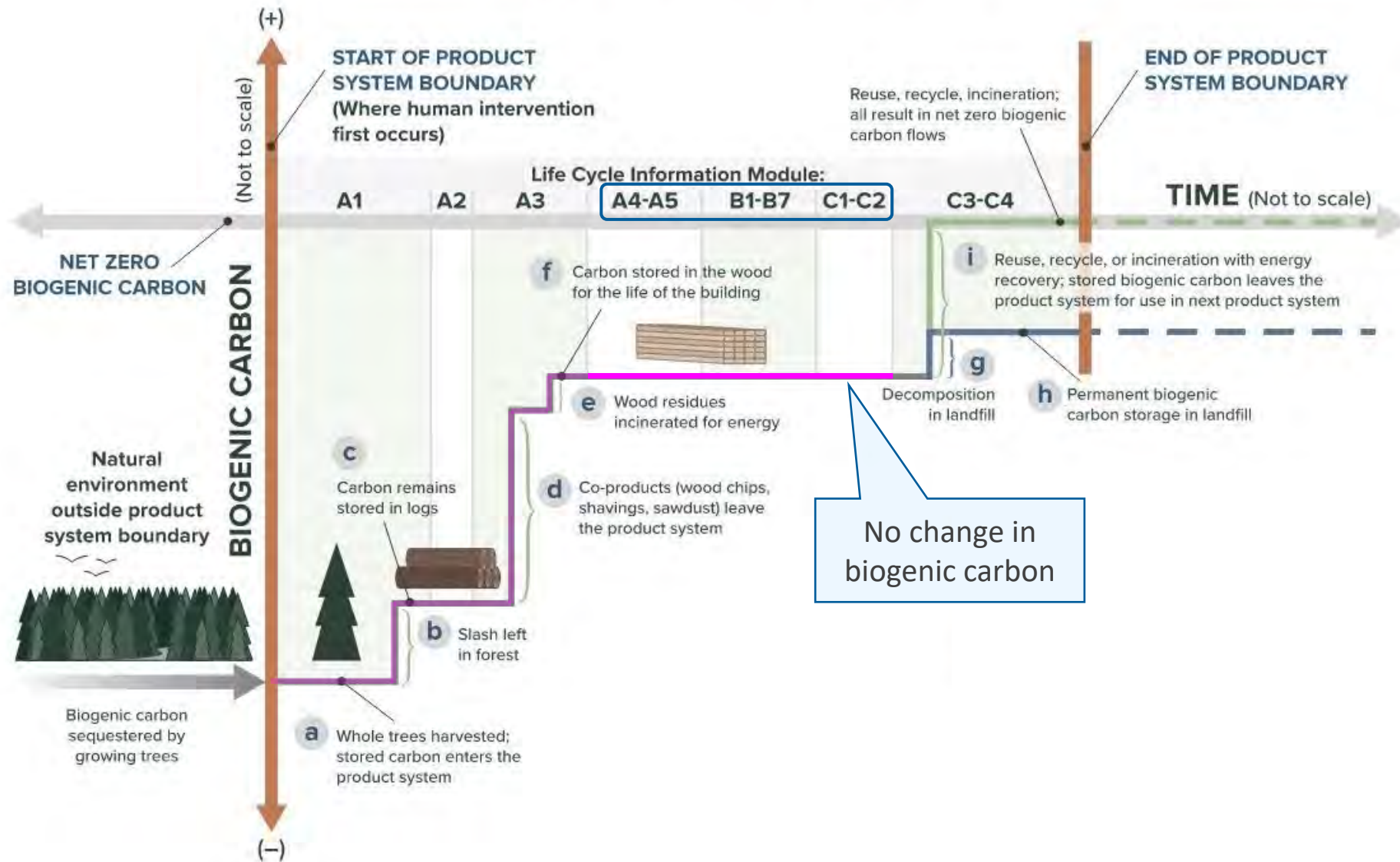
BIOGENIC CARBON FLOWS



BIOGENIC CARBON FLOWS



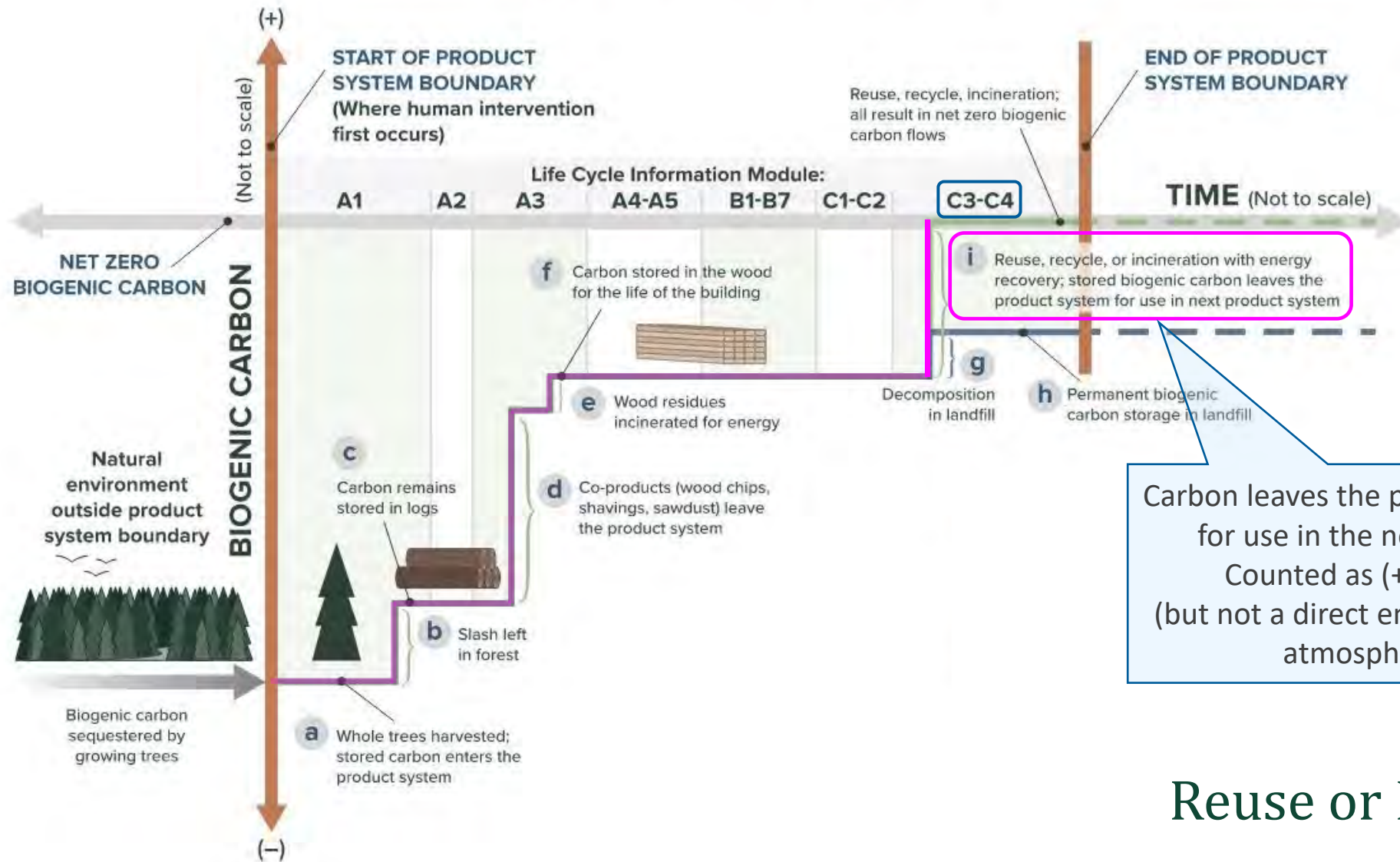
BIOGENIC CARBON FLOWS



End-of-Life Fates for Wood Products

1. Landfill
2. Incineration (for energy recovery)
3. Recycle
4. Direct Reuse

BIOGENIC CARBON FLOWS



The diagram illustrates the Biogenic Carbon Life Cycle Information Module, showing the flow of carbon from the natural environment through a product system and back to the environment or the next product system.

Vertical Axis: Biogenic Carbon (Not to scale). The positive direction (+) is upwards, and the negative direction (-) is downwards.

Horizontal Axis: TIME. The product system boundary is defined by two vertical lines: "START OF PRODUCT SYSTEM BOUNDARY (Where human intervention first occurs)" and "END OF PRODUCT SYSTEM BOUNDARY".

Life Cycle Information Module: The module is divided into stages: A1, A2, A3, A4-A5, B1-B7, C1-C2, C3-C4, and A1.

Carbon Flows:

- a** Whole trees harvested; stored carbon enters the product system.
- b** Slash left in forest.
- c** Carbon remains stored in logs.
- d** Co-products (wood chips, shavings, sawdust) leave the product system.
- e** Wood residues incinerated for energy.
- f** Carbon stored in the wood for the life of the building.
- g** Decomposition in landfill.
- h** Permanent biogenic carbon storage in landfill.
- i** Reuse, recycle, or incineration with recovery; stored biogenic carbon product system for use in next product system.

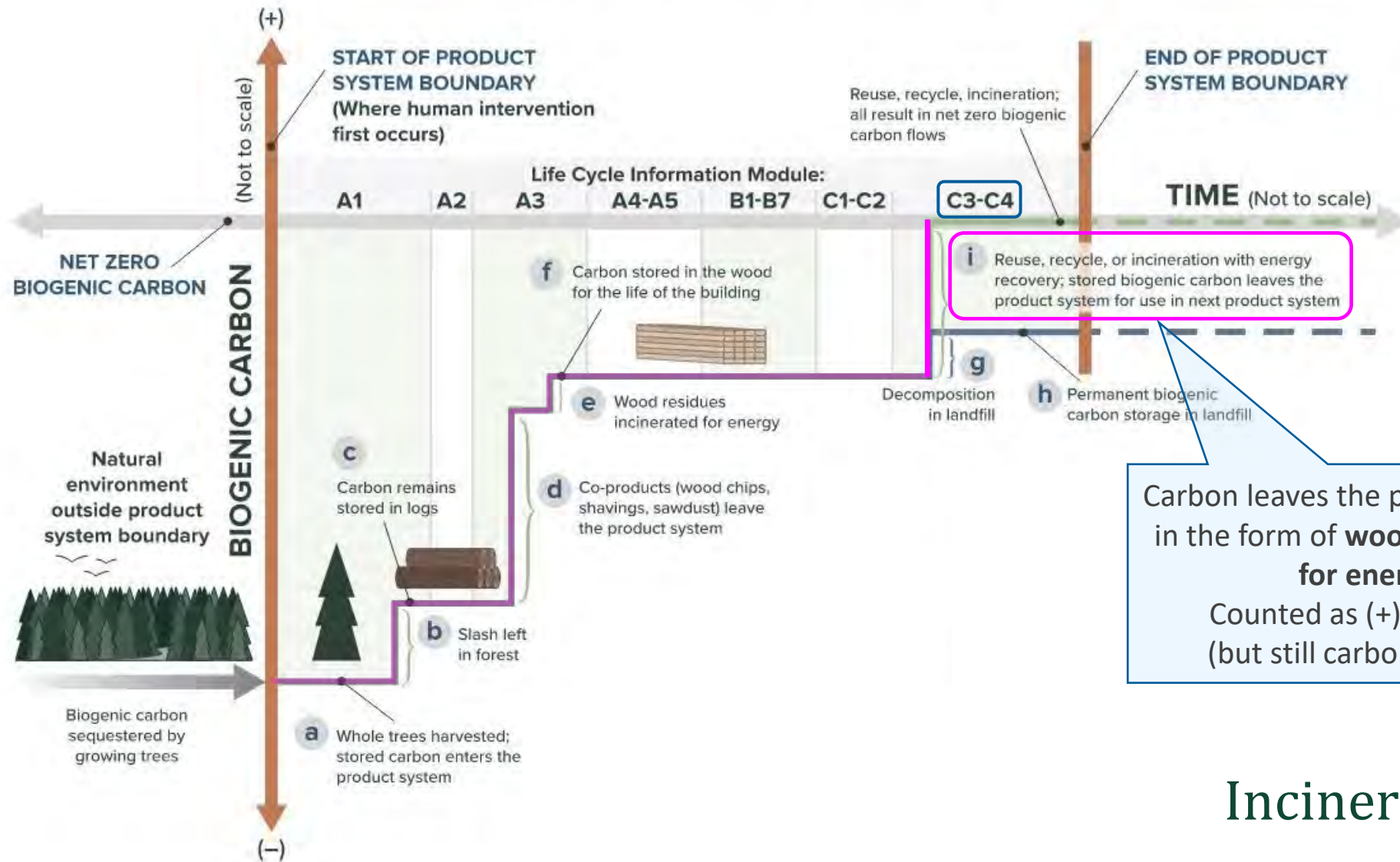
NET ZERO BIOGENIC CARBON: A horizontal line indicates the net zero biogenic carbon level.

Natural environment outside product system boundary: Biogenic carbon sequestered by growing trees.

Hypothetical: Benefits get picked up by A1 of the next product system.

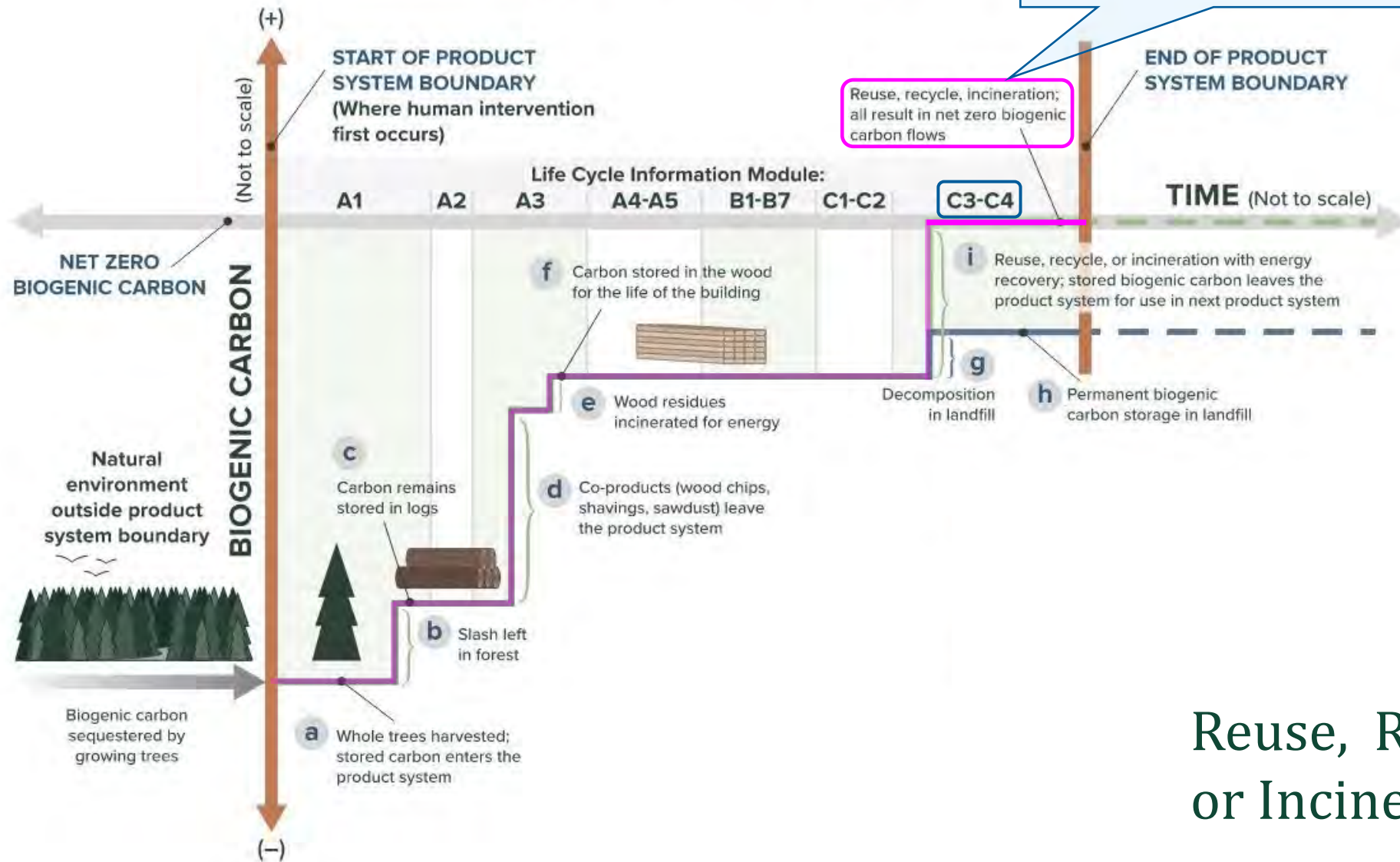
Hypothetical:
Benefits get picked up by
A1 of the next product system

BIOGENIC CARBON FLOWS



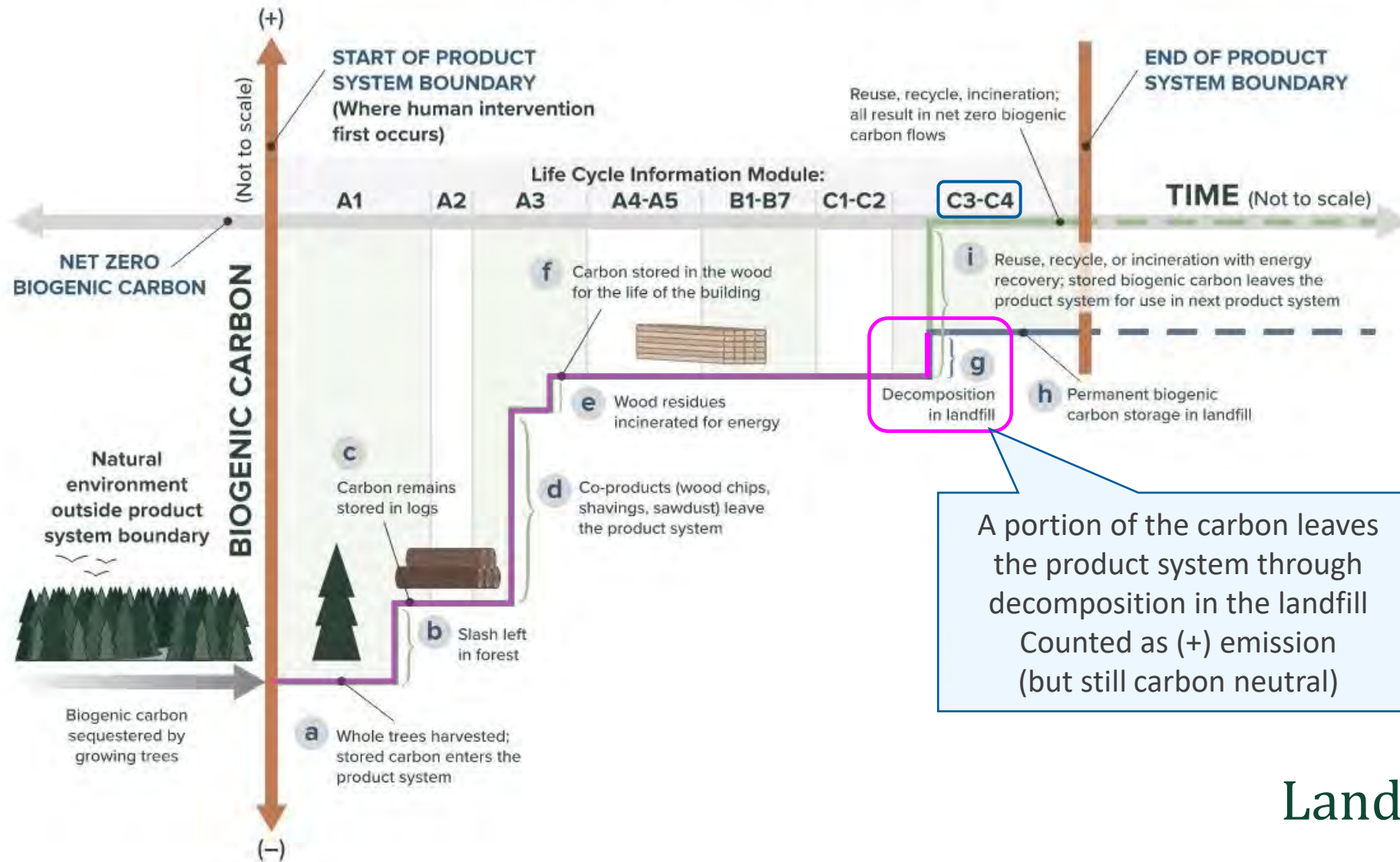
Incineration

BIOGENIC CARBON FLOWS



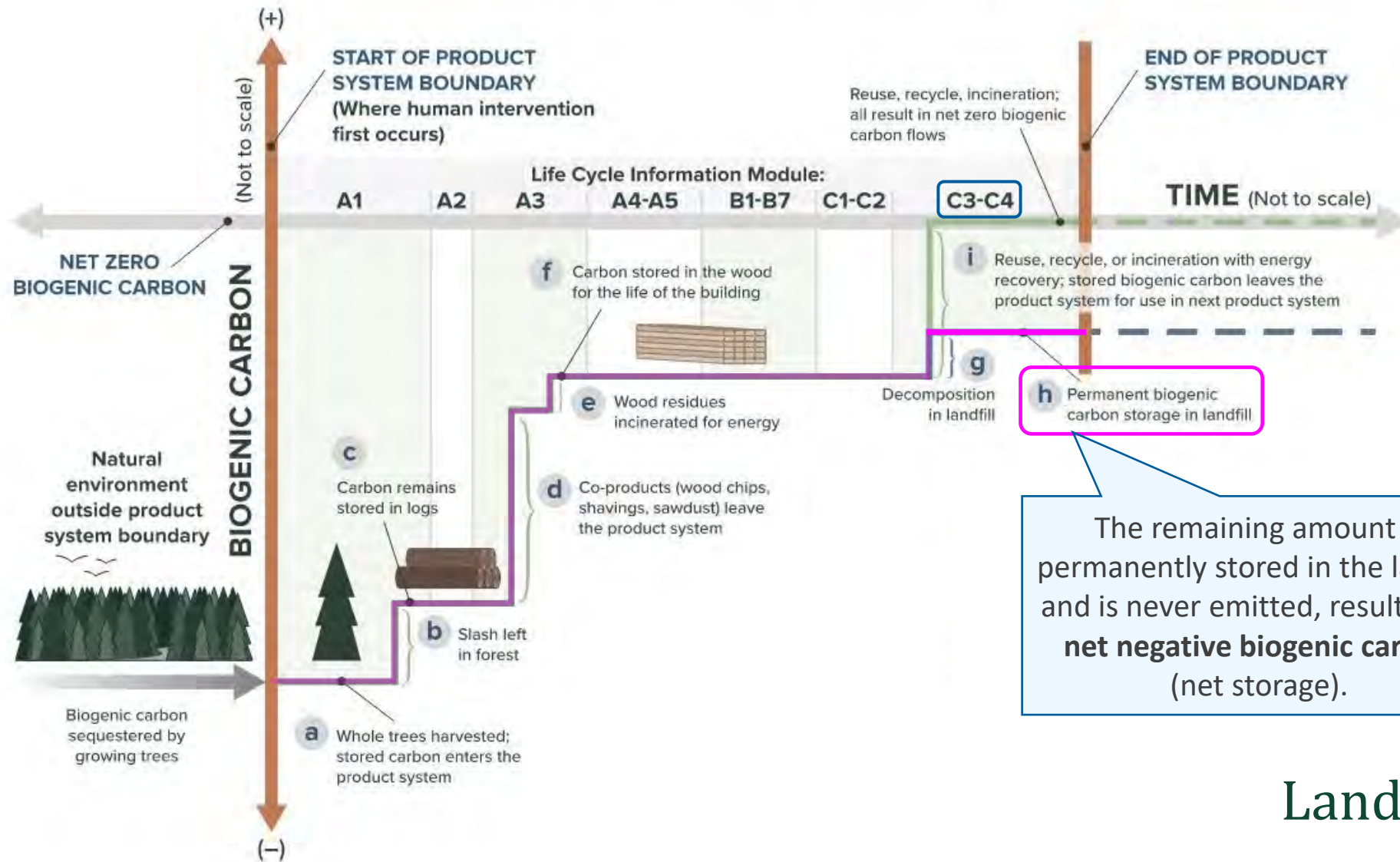
Reuse, Recycle
or Incineration

BIOGENIC CARBON FLOWS



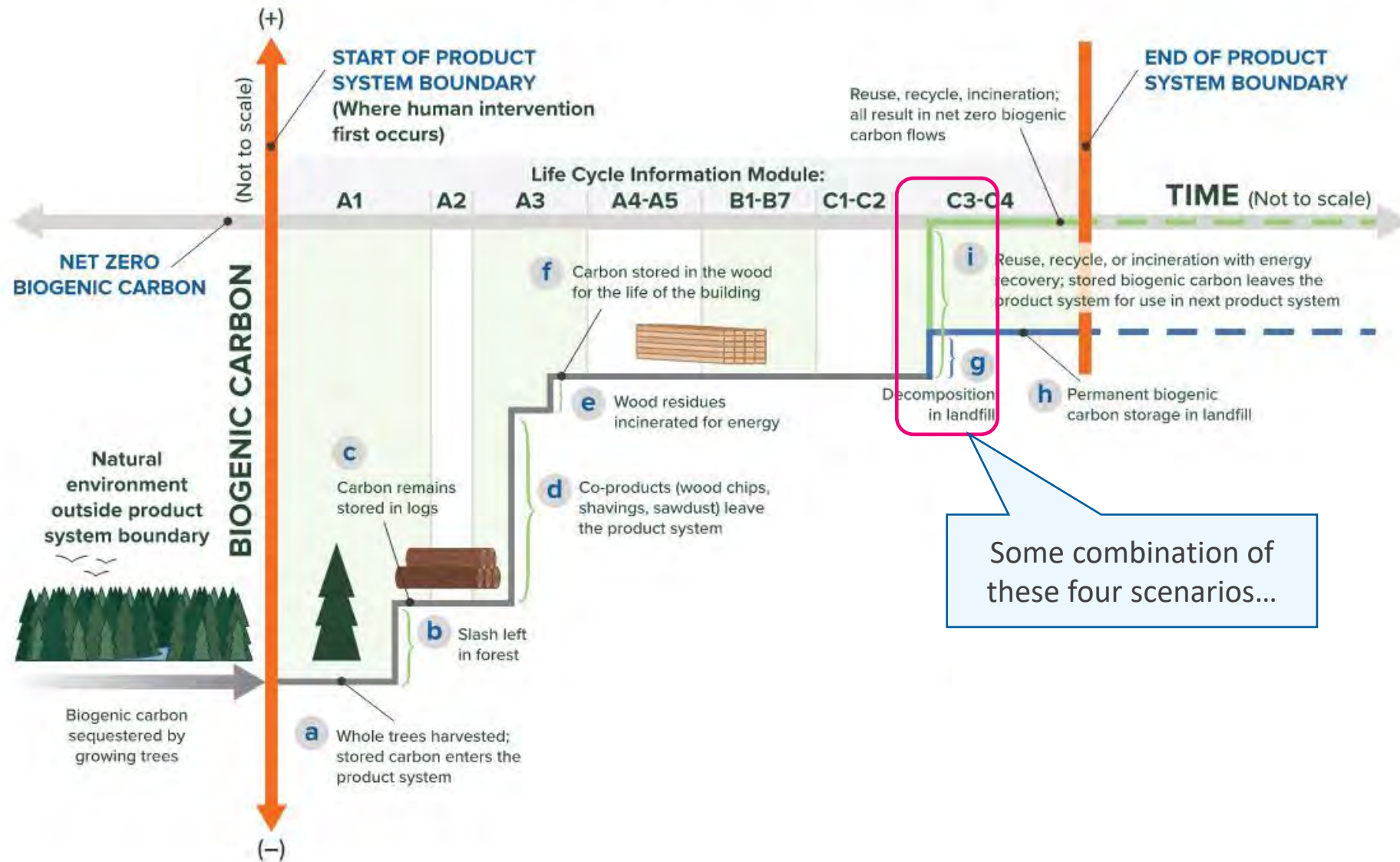
Landfill

BIOGENIC CARBON FLOWS

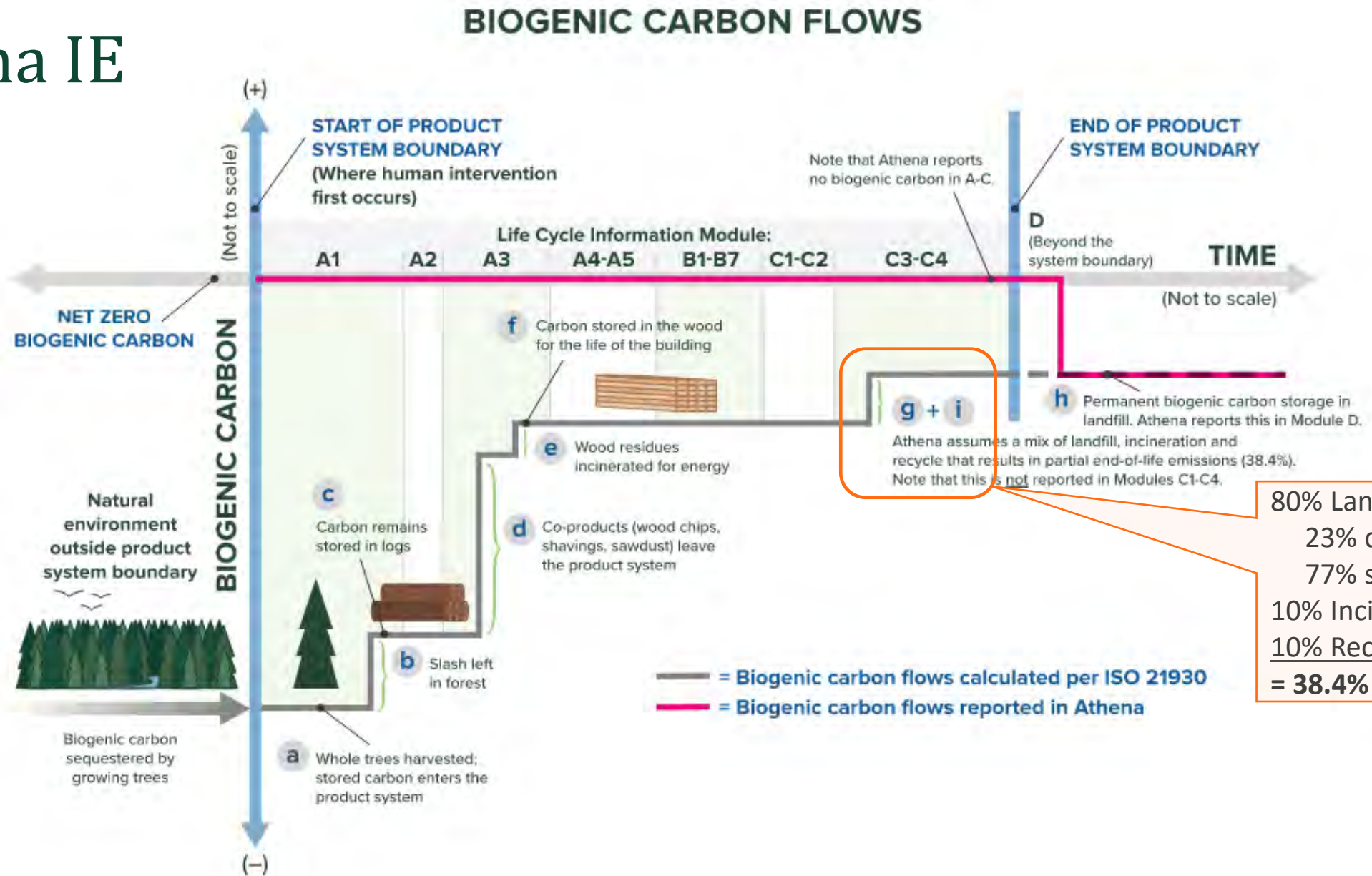


**What end-of-life option
should I use?**

BIOGENIC CARBON FLOWS

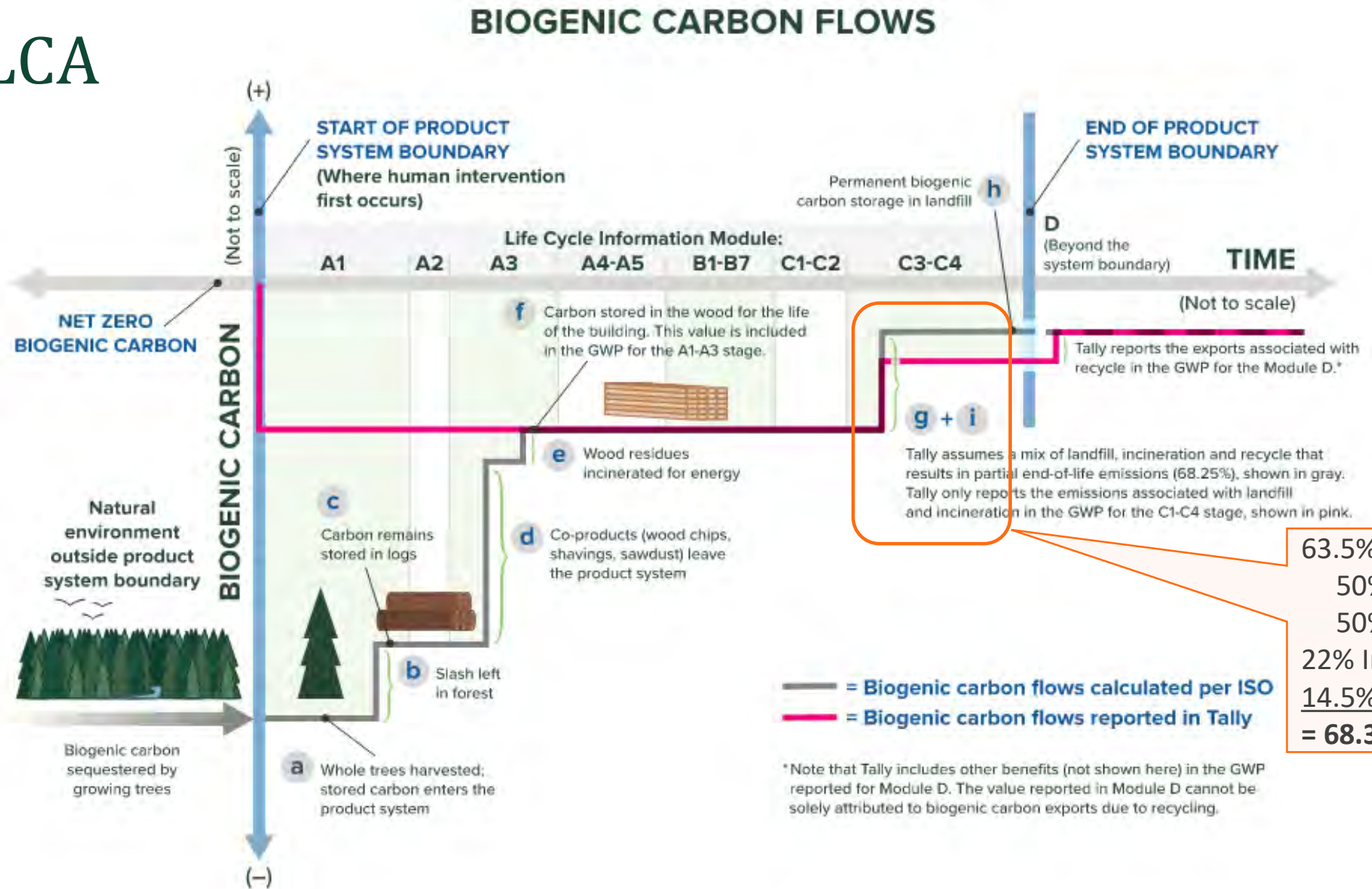


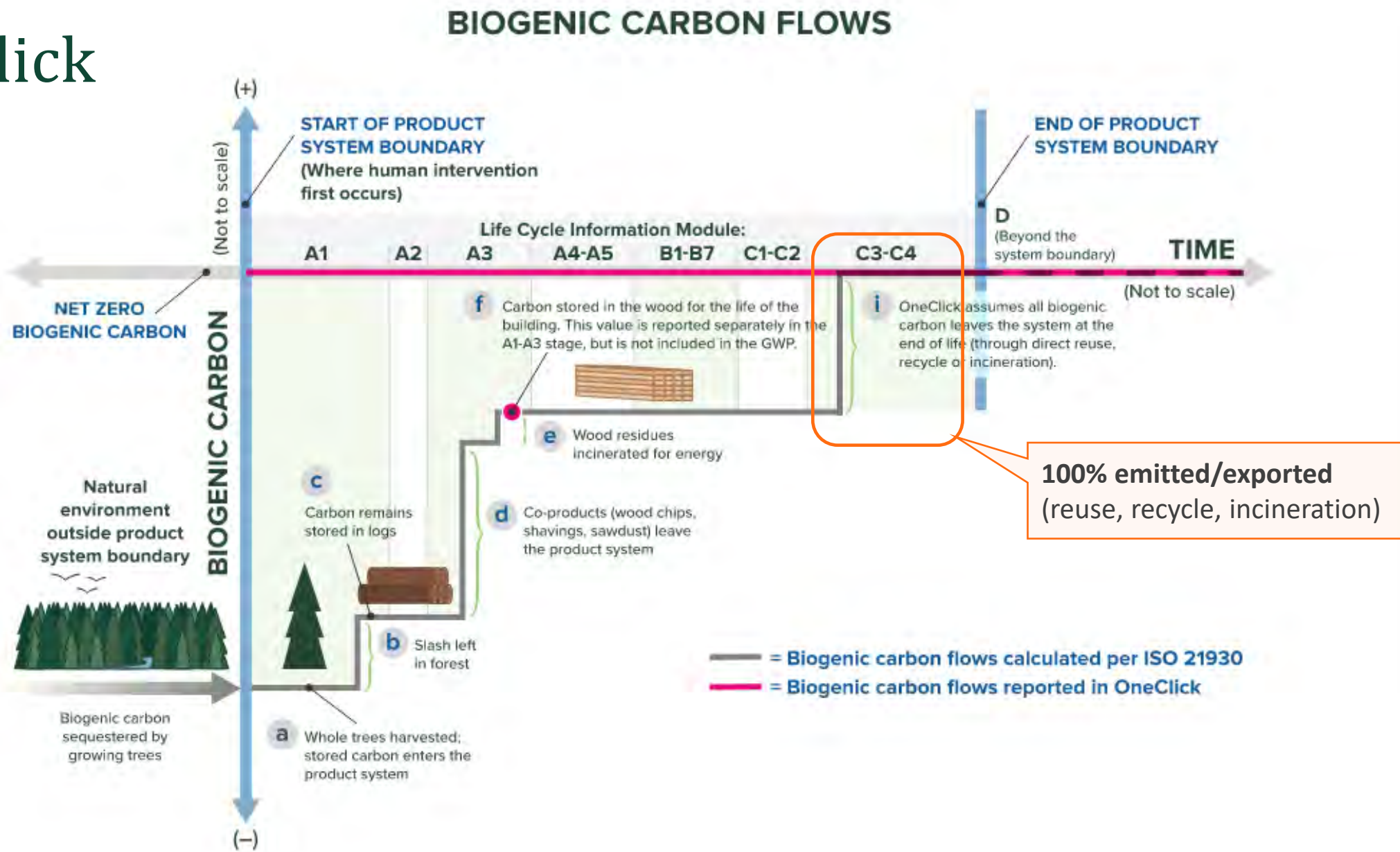
Athena IE



80% Landfill
23% decompose
77% stored
10% Incineration
10% Recycle
= 38.4% emit/export

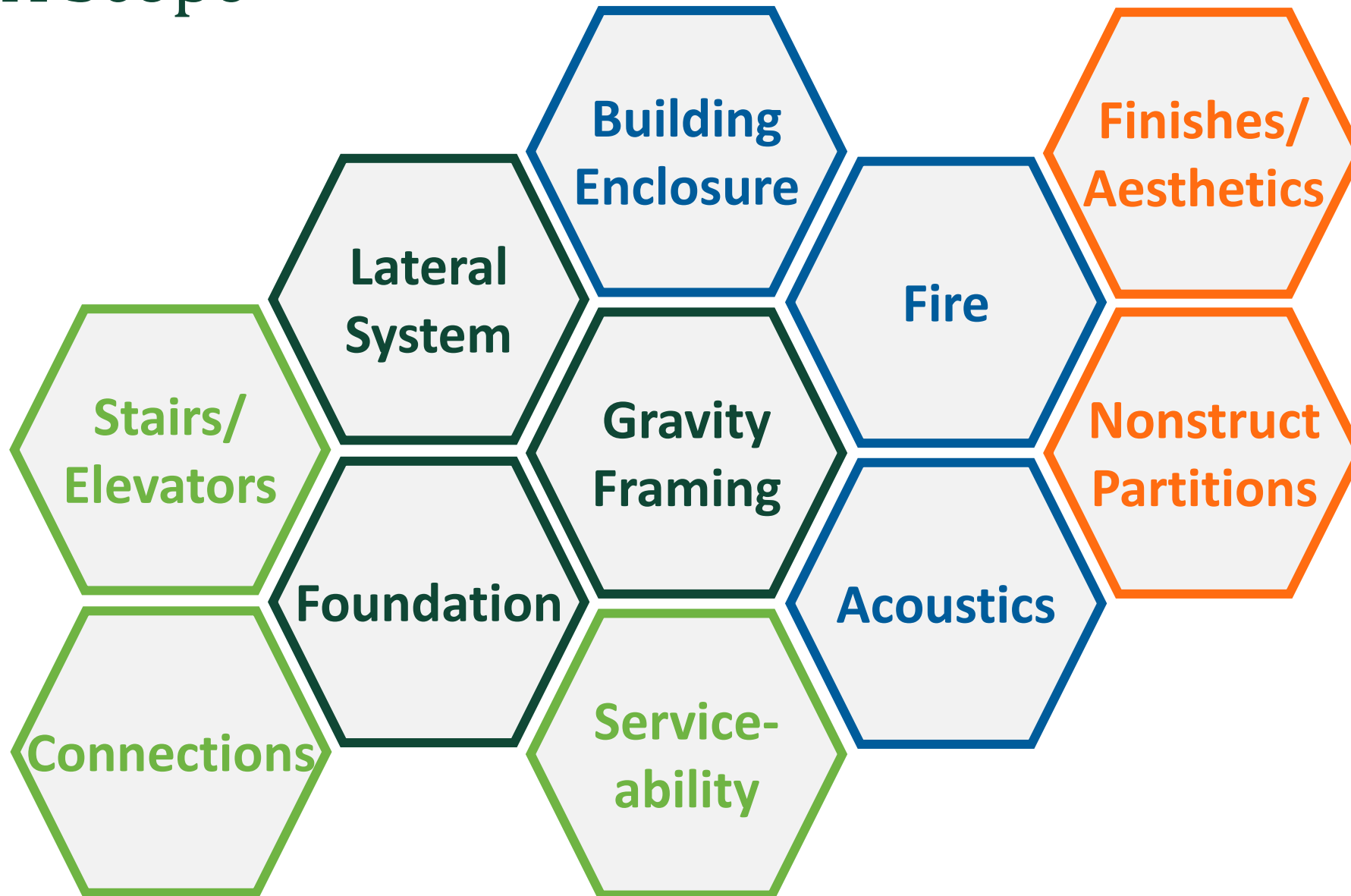
TallyLCA





How to Compare Structures

WBLCA Scope



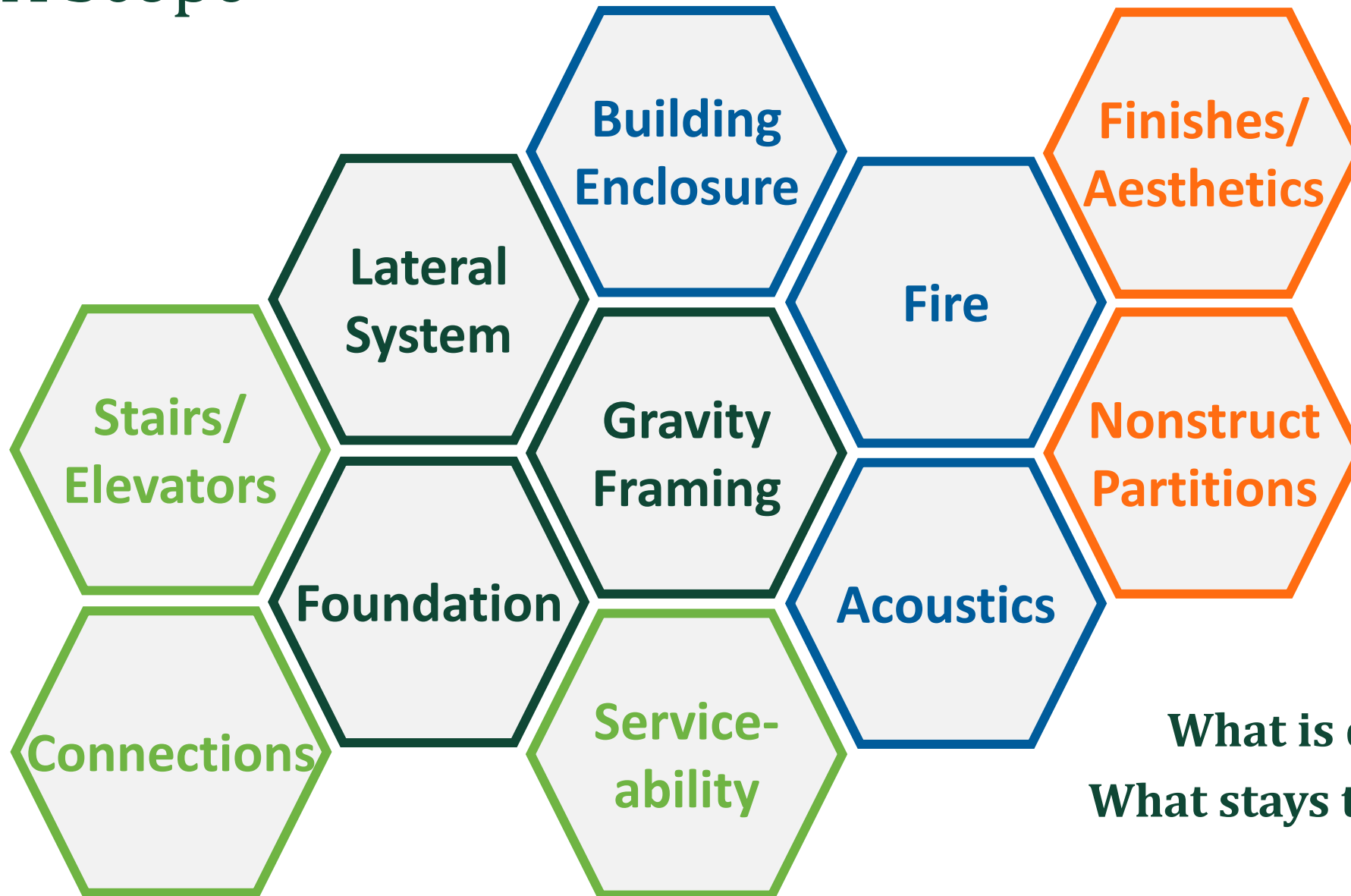
Comparative WBLCA

Mass Timber Building vs **Steel or Concrete Building**

requires

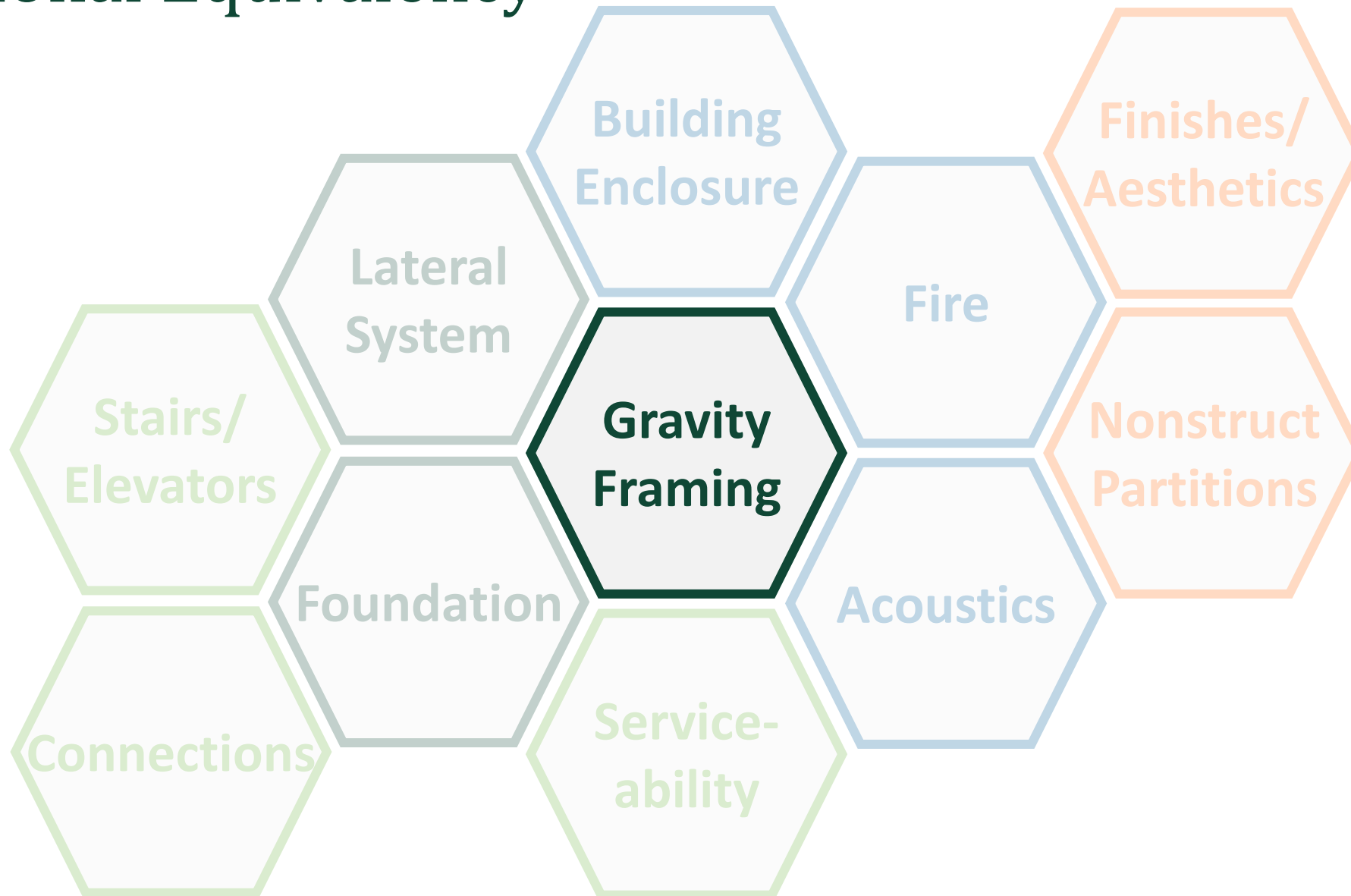
Functional Equivalency

WBLCA Scope

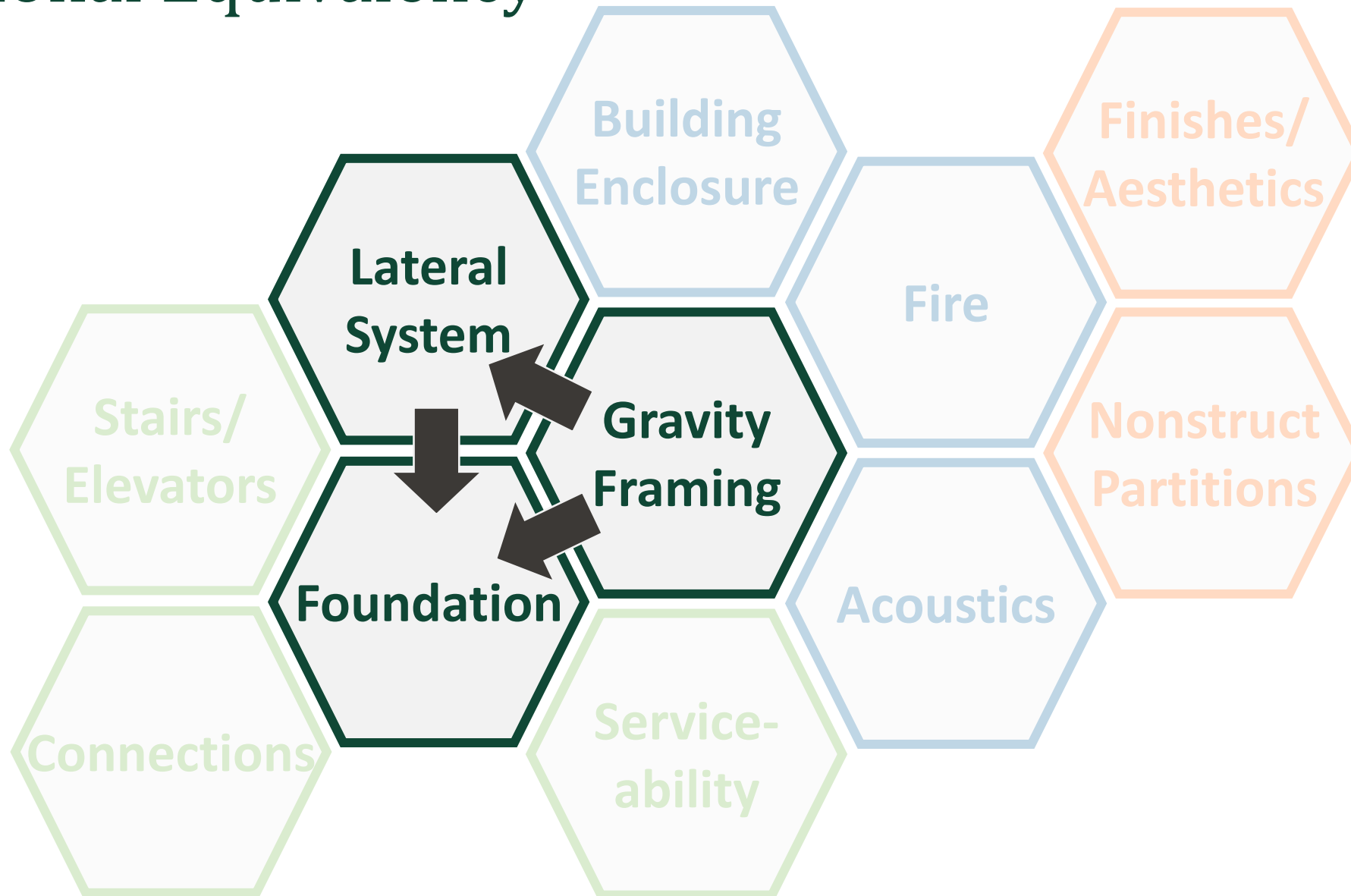


**What is different?
What stays the same?**

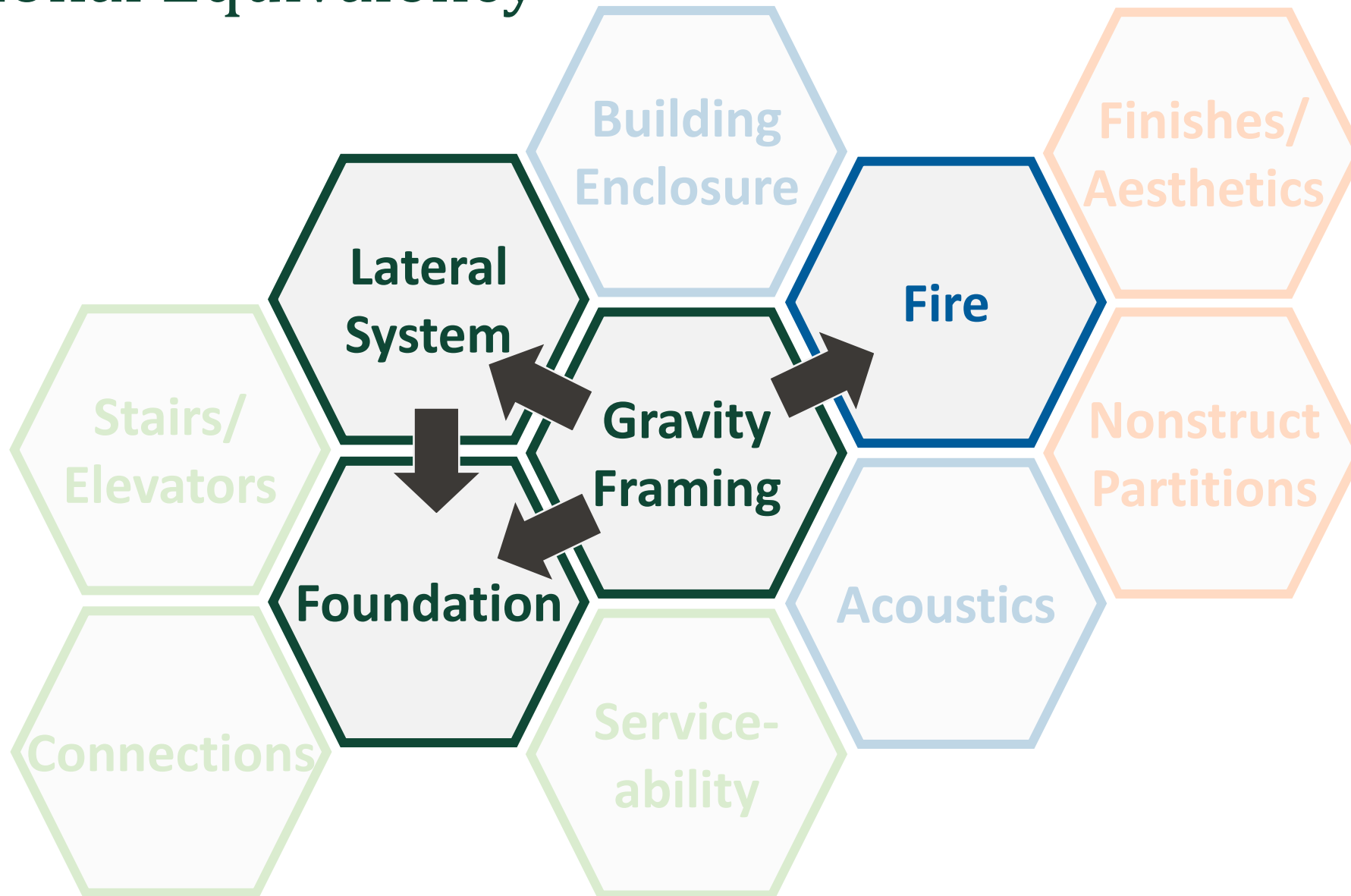
Functional Equivalency



Functional Equivalency



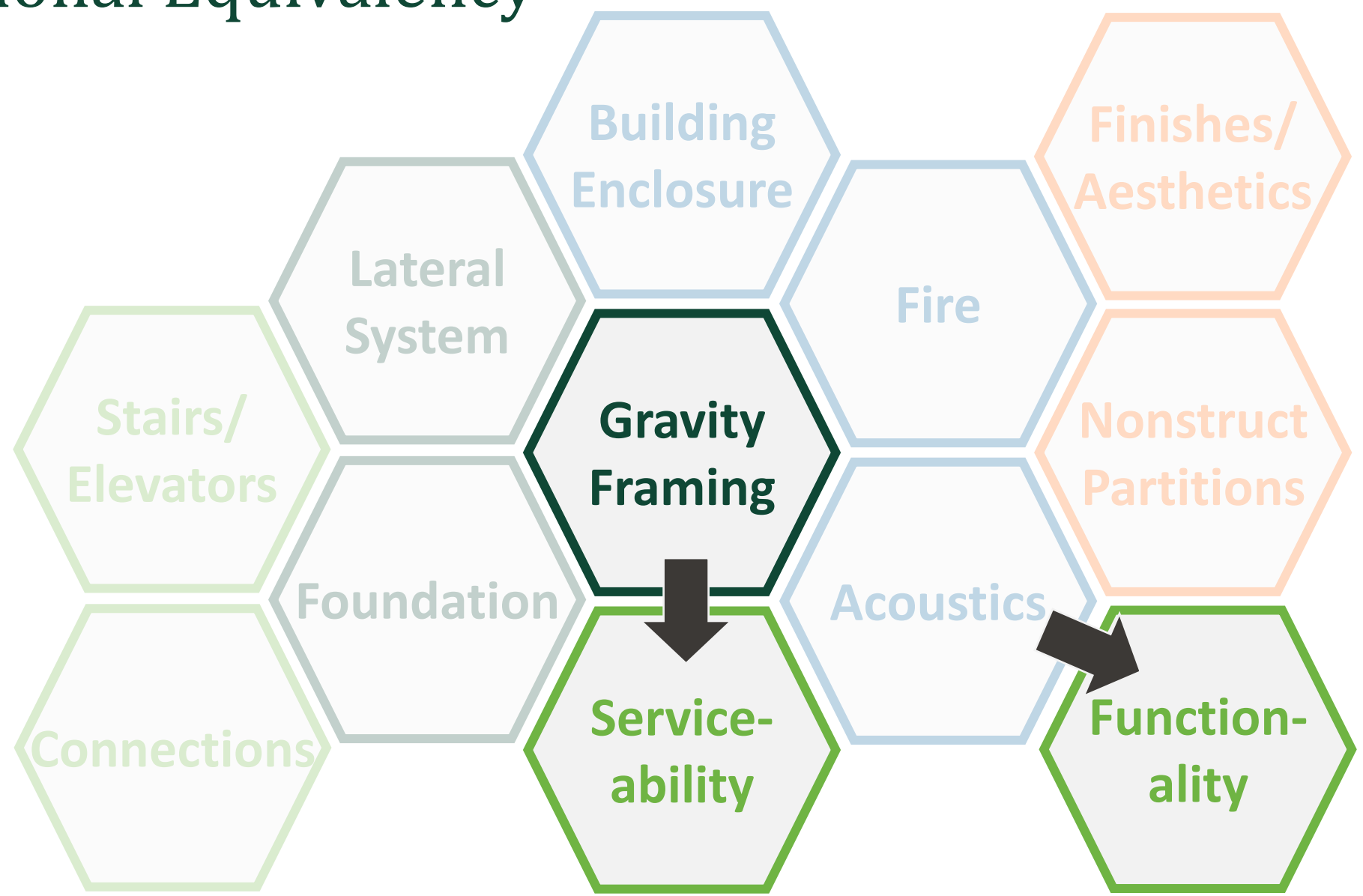
Functional Equivalency



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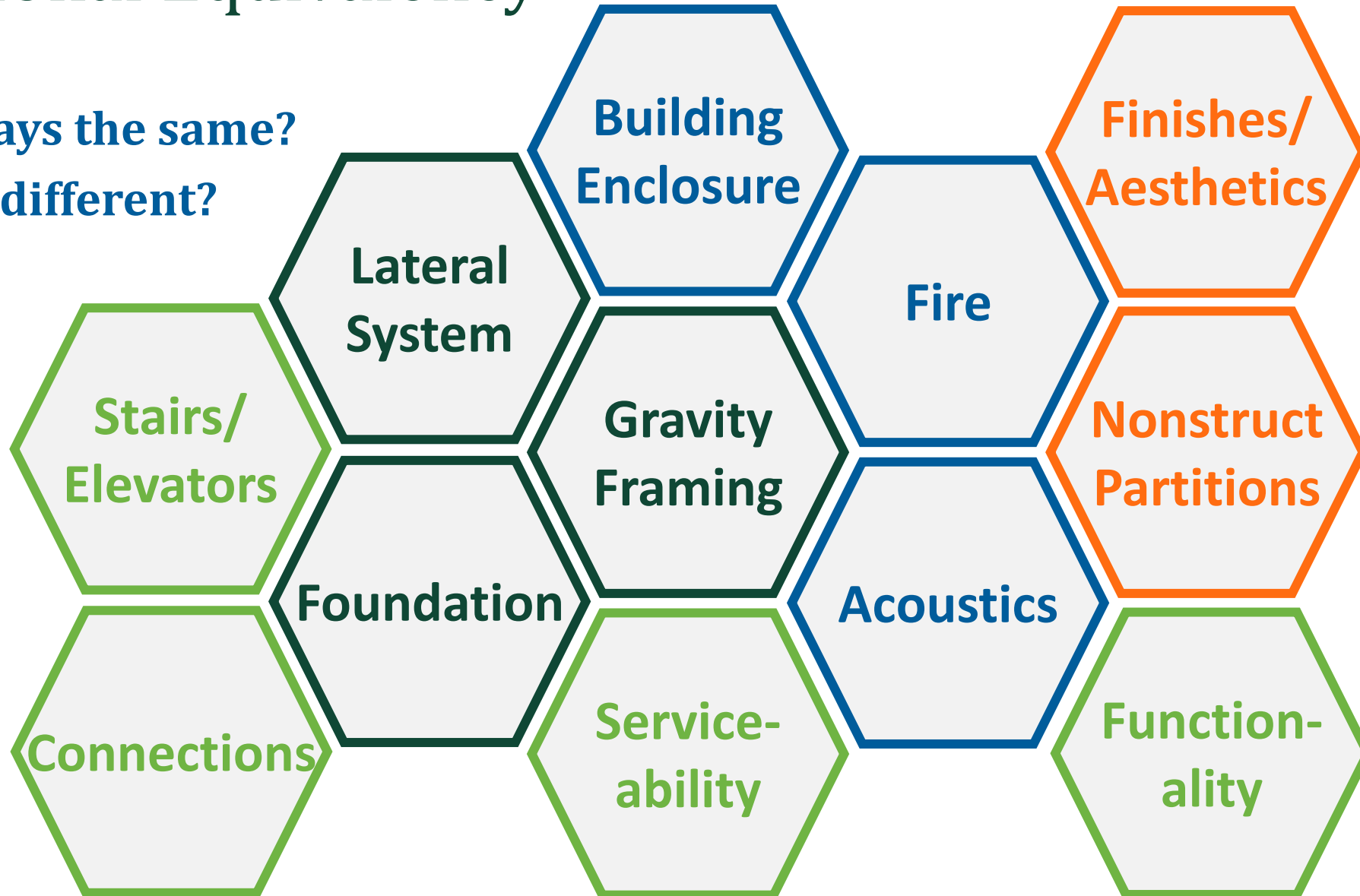


Functional Equivalency



Functional Equivalency

What stays the same?
What is different?





Resources from WoodWorks

Whole Building Life Cycle Assessment (WBLCA)

- » Introduction to Whole Building Life Cycle Assessment: The Basics

Biogenic Carbon and Carbon Storage

- » When to Include Biogenic Carbon in an LCA
- » How to Include Biogenic Carbon in an LCA
- » Biogenic Carbon Accounting in WBLCA Tools
- » Long-Term Biogenic Carbon Storage
- » Calculating the Carbon Stored in Wood Products

Environmental Product Declarations (EPDs)

- » Current EPDs for Wood Products
- » How to Use Environmental Product Declarations



Scan to view

QUESTIONS?

This concludes The American
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Education Systems Course

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WoodWorks – Wood Products Council

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